HISTORY PRIMERS

Edited by JOHN RICHARD GREEN

GEOGRAPHY

SIR GEORGE GROVE F.R.G.S.

Geog & Travel

History Primers. *Edited by* J. R. GREEN.

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BY

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WITH MAPS AND DIAGRAMS.

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HISTORY PRIMERS.

GEOGRAPHY.

1. **Geography** is from two Greek words, γῆ, *ge*, the earth, and γραφή, *graphé*, description; and that is what it is, a description of the earth; not of what is below the surface, for that is geology, but of all that is to be seen on the face of it—the land, the sea, the mountains, and valleys, and rivers, and lakes, and all the rest that meets the eye. Nor of these only in themselves, but an account of them as they are concerned with the inhabitants of the world. It is sometimes said that there are three kinds of geography—mathematical, physical, and political—of which the first has to do with the shape and size of the world, and the making of maps; the second with the form of the ground and its influence on man; the third with the divisions and history of nations and peoples. But all three are embraced in the word **Geography,** and therefore a **Primer of Geography** must have to do with them all. Nor do I see how they can well be separated; for neither the form of the globe, nor the arrangement of the land and water, nor the divisions which nations have made between themselves, are of any moment except as they concern us; and the three are so connected and mixed up together that

no right view can be taken of one without the others in some way interposing.

2. This is a little book, and therefore all our descriptions must be short. Long accounts of the countries with full particulars about them must be left for another time. I shall not give you any particulars of the history of Geography. What the ancients knew of it you will find in the *Primer of Ancient Geography*. Nor shall we do more than glance at the processes by which the earth became what it is, how the mountains were lifted up and the valleys scooped out; for that is done to perfection in the *Primer of Physical Geography*. And we shall touch as little as possible on Astronomy, because you will find that in the *Primer* and *Elementary Lessons* on that science. But I shall try to give you a general knowledge of what the world is and what its different parts are like, and so prepare you for a longer and fuller account elsewhere. I shall shew you:—

I. What Maps are, why they are wanted, and how they are made.

II. What are the general structure and arrangement of the Earth and Ocean.

III. Some particulars of the features of Land and Water.

3. And first about

MAPS AND MAP-MAKING.

When you sit down to a game of chess or draughts, you have the board under your eyes, and can see and touch every part of it. But suppose the board were ten miles square, and you had still to play the game, what would you do? You would have a small representation or **map** of it made, the size of a sheet of paper, which you could keep before you and mark all the moves upon.

4. Suppose again you had been the commanding officer at some great battle, and wished to explain the movements of the troops to a friend, to shew how this farmhouse was taken, that clump of trees occupied, and that road defended, in short how the battle went from beginning to end; what would you do? You would draw it all out small on a piece of paper, in the same proportions, and with the places and things in their positions with regard to each other, just as it would look if you were hanging over it in a balloon; in other words, you would make a **map** of it, and then you could easily shew your friend where the regiments stood, and how the batteries were placed, and in short could go through all the successive operations of the day, and make them plain to him, plainer than they were in the battle itself, where only one part could be seen at a time.

5. Suppose once more that you had to walk from London to Brighton, and did not know the way, and had no one to shew it you. You would be utterly puzzled. You would not know whether you were walking towards Brighton or Reading or Chatham. You could not see the town in the distance, and every hedge or house or ridge would shut out the view before you, and quite bewilder you. But if I brought you a **map** with everything marked upon it, you could then draw a straight line to Brighton, you could see where the line cut the places on the map, and so by degrees find your way along, field by field, and village by village, keeping this place to the right and that to the left, till you arrived at your journey's end.

6. Now here are three cases in which without a map you could not get on at all. No dcubt they are never likely to happen. But they are good examples of what *does* happen every day. If all men were fixed for life in the places they were born in, and never travelled, and had no concern with people of other places and countries, maps would be of little use. But we *do* travel, we have business all over the world, friends in India, friends in America; ships sail about the ocean where for days and weeks they see no land, and have no apparent means of finding their way; armies go into an enemy's country, where it is important not only to find their way but to know the distance exactly, to an hour's march or less; and for all these things maps are indispensable, and so the science of Geography has grown up, and the method of **making maps,** and of **understanding them** when made—of representing on paper the surface of the earth, with what may be called its features, all the indentations of the coast, the bends of the rivers, the extent of the forests, the lie of the mountains, as well as all the cities, villages, roads, railways, canals, and so on, in the same positions and proportions as they are in reality, only far smaller, just as they would appear if you could look at the world from a distance.

7. Not a picture, that is a different thing—different in nature and different in object. A map is not made to please, so much as to instruct. It aims to show the shapes and positions of the features of the earth, not as they rise before the eye in all the beauties of the sun and air, and in their vertical, upright forms, but as they are stretched out horizontally at one's feet. Suppose you saw an ant running about the table-cloth at dessert among the dishes and decanters. It sees the

things on each side of it, but it can have no knowledge of their shapes, and the way they are arranged; it is too small for the purpose. If it could raise itself to the same height above the table that your eye is, and have the same power of sight, it would see the whole at a glance, and be able to make its journeys without loss of time or trouble. Now the table-cloth is the country, the ant is you, and **the view is a map.**

8. But are you sure that when you have got the map you will be able to **read** it? There was a time when you could not read a printed book, before you knew the letters, and how to put them into words, and words into sentences. Oh but, you say, a map is a different thing. I can understand it at a glance. Can you? Shew a savage, even an intelligent savage, a photograph or portrait, and you would think it impossible that he should not know that it represents a man or a woman. But the savage will not have the least idea what it means; he will not even know whether it is upside down or not; he will see no more in it than he would on a blank bit of paper; the picture which to you is so plain to him says nothing, and I am very much mistaken if the map says very much more to you. At any rate it will not say all that it has to say. For instance, what are the lines drawn up and down across it, and the figures at the ends of those lines. Can you point out to me the watershed or basins of the rivers? Do you even know the meaning of the words? Can you distinguish roads from rivers, or either of them from canals? or could you trace with your finger a line over the country which should keep the same level everywhere? Could you shew me the shortest road across the ocean between two places, say between

Cape Horn and Canton? Probably not; but until you can do this, and a great deal more, you can only read the map imperfectly.

9. It is with the ground-plan of the earth's surface that geography has to do, and to profit by it we must know how maps are made. Now we know from our *Primer of Astronomy* that the earth is a very large ball about 8,000 miles through, the outside of which is formed of the land and water that make up the various countries. They form the skin of the earth as the peel forms the skin of an orange; and just as you can take an orange, and mark a line right round it, and come back to the same point again, so you may set out from London, or any other place, and go always in one straight direction, and at last, after many months, come round to London again, which you could not do if the earth were anything else but a great ball.

10. Now as the earth is a ball it seems plain that the map of the earth should be a ball too. And so it may be; we have them, and we call them **globes**, and for getting a general idea of the world and the countries upon it nothing can be better than a globe. But there is one drawback, that if it were made sufficiently large to shew the details of the map, it would be quite unmanageable, too cumbrous for use, and also too expensive. The largest globes that we see in libraries and museums are yet so small that nothing can be given upon them but the general features of the countries—few details of rivers or roads or mountains or towns, or other important things; with the palm of your hand you may cover the whole of England; a great city is no bigger than a pin's head, and your house and garden are invisible. An attempt was once made to

make a really large globe, which was shewn in Leicester Square, London, under the name of Wyld's Great Globe,—but though its advantages were great its disadvantages were greater, and it was soon given up.

11. Our maps then must be flat. But to get a flat representation of any large portion of a curved surface is simply impossible. Take a piece of paper and attempt to fit it to the surface of a ball or globe, and it cannot be done, there will be always a number of creases in the paper; and though the larger the globe and the smaller the piece of paper the smaller the creases will be, yet some will always remain at the edges to shew that the plane surface cannot answer exactly to the curved one. **A flat map therefore can never be absolutely correct;** it will at the best only come near the truth.

12. To see how the difficulty is got over, we will begin by considering a spherical map, or what is generally called a terrestrial globe, since it is the foundation of all map-making. And before we go any farther we must fix on a few words, so that we may understand exactly what we mean, and have no confusion. In Geography we do not say Top and Bottom, Right and Left; but we call them north, south, east, and west. When you are in front of a globe or map, the top is the **north,** the bottom is the **south,** the right hand is the **east,** the left hand is the **west.** Also, as the earth is a ball spinning round from West to East, as if on a pole or axle-tree run through it, it has been agreed to call the extreme north spot of the earth the **North Pole,** and the opposite one the **South Pole.** If we lived in Australia, we should then look to the South Pole in

the same way that in this country we look to the North; the left hand would be the East, and the right hand the West. Again, in this Primer when we say the *Earth*, we mean the actual world itself; but when we say the *Globe*, we mean the representation of it of which the following is a picture:—

Fig. 1.

13. There is the globe then, or rather one side of it, one half, a Hemi-sphere; and two questions at once occur to us—What are all those lines drawn up and down and across it? and How were all the countries and places got into their proper places just as they are on the earth itself? Two better questions it would be impossible to ask, or two that depend more strictly on each other. **The lines are there solely for the purpose of fixing the places, and the places could not be fixed without the lines.** The lines

which run from top to bottom—North Pole to South Pole—are lines or **meridians** of **longitude**; you see that there are 36 of them, 18 in each hemisphere, and they divide the whole circumference of the globe into 36 equal parts, each of which again is subdivided into 10 degrees, or 360 degrees in all. The lines which run round the globe from west to east, at right angles to the meridians of longitude, are called **parallels of latitude**, and of these you see there are 17. The middle one, which goes round the world at its largest part, is called the **Equator**, and there are 8 to the north and 8 to the south of it, dividing the space between the Equator and each Pole into 9 parts; and these also are each of 10 degrees. They are numbered from 1 to 90 upwards and from 1 to 90 downwards, and those above the Equator are called parallels of **north** latitude, those below it, parallels of **south** latitude.

14. The meridians of longitude are all the same size. Each one goes through both North Pole and South Pole, and therefore runs right round the globe; and each is called a **Great Circle** because it is the largest circle that can be drawn on the globe. Thus there is no one meridian larger than the rest to form a natural starting-place, as the Equator does for the parallels, and therefore a special one has to be chosen to count from—ten, twenty, thirty, to the right, and ten, twenty, thirty, to the left, till they meet at 180. The English choose that which runs through Greenwich Observatory, and call those east of it in East longitude, those west of it in West longitude. The French take a line passing through Paris; others have taken Ferro, one of the Canary islands. It is

quite immaterial which is chosen, as long as we know it; since all the lines are alike, and all that is wanted is one to start from. But in the case of the latitude all agree to take the Equator as the starting-point, as being the largest of all the parallels, and standing naturally in the middle between those north and those south of it. For if you think a little, and if you look at the picture,

Fig. 2.

you will see that the circles round the globe, which we call parallels of latitude, must inevitably get less in length as they are farther off from the Equator, until at last they come to nothing at the Poles. There is only one Great Circle among the whole 17 parallels, and that one is the Equator.

15. Now the Equator is divided into 360 **degrees** (written °), and the meridians into 360 degrees also;

and each degree into 60 **minutes** (written ′), and each minute into 60 **seconds** (written ″), which have nothing to do with the minutes and seconds of an hour, though they are called by the same names and divided by sixties. And thus 32° 19′ 27″ means 32 degrees, 19 minutes, 27 seconds. Further, each **minute**, each sixtieth part of a degree of the equator or the meridians, is a **mile**—not a common English mile, but a geographical or nautical mile, or **knot**. Reckonings in navigation are usually made by geographical miles, and to avoid confusion we will always call them **knots**. They are longer than our common English statute miles as 2,028 is longer than 1,760, or as 69 to 60 nearly; and at the end of the book you will find a table of comparison between the two.

16. Now we will go a step farther. Each meridian is divided into 360 degrees, and each degree into 60 minutes, or 21,600 in all, and each of those minutes is a knot, for all the meridians are Great Circles of the same length; and the Equator also is divided into 360 degrees and 21,600 minutes, and each minute is a knot there too, because the Equator is a Great Circle also. But remember it is the only Great Circle among all the parallels. From the nature of the case each parallel is smaller than the last, and therefore the value of the degrees and minutes into which they are divided—that is to say, the degrees and minutes of longitude which are counted along them—gets smaller too, till, at the Pole, it comes to nothing. At Greenwich (N. lat. 51° 28′ 40″), the value of a degree of longitude is only about 37 knots instead of 60. You must please to think over this, as between the degrees and parallels and meridians it is a little puzzling. As long as you measure by degrees, minutes, and seconds,

there is no difficulty. Two meridians that were 10 degrees apart at the Equator are 10 degrees apart at any spot between the Equator and the Pole, the proportion is always exactly the same. Some watches have a hole in the case with a set of figures round it, and though the hole is only half the size of the inside face, yet the time is always the same on both. When it is 20 minutes to 5 on the large set of figures it is 20 minutes to 5 on the small one, though so much smaller; and just so the distance between the meridians on the globe decreases in exact proportion, and degrees are always of the same relative value, which is a great convenience for measuring off. But when you begin to translate the degrees into knots you find that the minutes of longitude are continually growing smaller as they approach the Poles, or, in other words, that each degree of longitude contains fewer knots. At the end of the book you will find a table for this also.

17. By the help of this apparatus of cross lines the position of any place can be fixed on the globe and described with the greatest accuracy. Thus Genoa is 44° 25′ N. lat.; that is, 44 degrees and 25-60ths of a degree, or 25 minutes, in North latitude, or north of the Equator; and it is also 8° 58′ E. long., that is, 8 degrees 58 minutes East longitude, or east of the meridian of Greenwich. San Francisco again is 37° 49′ North latitude, and 122° 8′ West longitude —west of Greenwich, and so on.

18. And then the convenience of it. You hear of a wreck taking place and the people suffering dreadful misery on some small island, as the crew and passengers of the *Strathmore* did on the Crozet islands in 1875. The papers are full of it, and of course you

want to see where it was. You might search the map of the world all over and the name would escape you. But if I tell you that it is in S. lat. 46° 16′, and E. long. 48° 27′, you can drop upon it in a moment.

19. But there is another service which these cross lines can perform. Put a man suddenly down at any spot on the earth, furnished with the proper instruments and able to use them, and he will be able to tell you the **latitude** and **longitude** of that spot. He will make certain **observations** of the sun, moon, and stars, and will look at his chronometer or clock, which keeps the same time as at Greenwich, and he will tell you how many degrees and parts of a degree he is north or south of the Equator, and how many degrees and parts of a degree he is east or west of the meridian of Greenwich; having got which knowledge the cross lines enable him to fix the spot on the map with accuracy. In the same way, ships can find out where they are on the ocean when out of sight of land; they take observations which give them their position east or west of the meridian of Greenwich, and north or south of the Equator. The captain measures off these two dimensions on his map, and then he can see whether he is sailing in his right course or not, and can act accordingly. What these "observations" are, and how taken, you will find explained in the *Primer of Astronomy*, at pages 108–114.

20. Thus what I said before about the globe (§13) is quite true. The lines are there for the purpose of fixing the places, and the places could not be fixed without the lines.

21. We are now able to get a rough general idea of the way in which a globe or spherical map of the earth might be made, supposing you were going to

make the first one that ever was. Having got your globe, and having marked the North and South Poles on it, and drawn the Equator midway between them, and the parallels of latitude and meridians of longitude, and numbered them, you would be in a position to begin to put down the information brought by navigators and travellers, as it arrived. For instance, some one who had been sailing to South America might report that he had seen four cities on the coast :—

Pernambuco . .	S. Lat.	8° 3′	W. Long.	34° 54′
Bahia . . .	,,	12° 42′	,,	38° 42′
Rio Janeiro . .	,,	22° 53′	,,	43° 12′
Buenos Ayres .	,,	34° 36′	,,	58° 24′

These four places you could at once put down on your globe, and they would form a beginning for South America. The same sailor, or some one else, would give you the line of the coast between these places, with the latitudes and longitudes of the principal points; and those too you would put down. Next week another navigator might arrive from Australia, or a traveller, like Lieutenant Cameron, from the centre of Africa, bringing a few points from each; and so by degrees your map would grow until the whole globe became covered.

22. And this is really how the globe has been made, only it has taken hundreds of years and thousands of people to do it. And it is not yet complete. Of the inside of Persia and of Australia much is yet to be known. Numbers of latitudes and longitudes of New Guinea were brought home by Captain Moresby in 1873. Tibet and the other great pastoral countries north of India are very little explored; and you know how many travellers, from Landor to Livingstone, have died in the endeavour to get latitudes and longitudes

in the heart of Africa, and how much has been added to the map by the Polar expeditions, from Cook, Ross, and Parry, to Payer and Nares. And there would be much to correct from time to time. It is not 20 years since the coast of Syria was found to be four miles out in all the maps, and the position of Jerusalem was correctly fixed for the first time.

23. So far for the globe. But we have seen that for ordinary use globes will not do, we must have **flat maps**; and the next question is, how are these to be made from the globe? That is to say, how are the cross lines to be put down? For I cannot too often remind you that the cross lines are the absolute foundation of every map. Therefore, in making a flat map from the globe, the parallels of latitude and meridians of longitude are the first things to think of. If we can get them accurately drawn all the rest will follow; get the skeleton right and we can easily clothe it with flesh, form, and colour. Now the skeleton will never be quite accurate, for we have already seen that a sheet of paper can never be fitted to the surface of a sphere. Many methods have been tried of overcoming this, and though they are only a choice of evils, yet practically they answer well. For in all science an error is only an evil as long as its exact amount is not known. When it is known it can be allowed for and overcome. And if we know how far off our parallels and meridians in the flat map are from being like those on the globe, we shall be able to allow for the mistake.

24. First therefore we have to transfer our meridians and parallels from the sphere to the flat paper. Now this transference is called **projection**—a pretty word: it is as if the sphere were hollow, made of thin glass,

and we were seated inside it looking through, and as it were *projecting* the lines upon it on to the paper beyond. And indeed, speaking roughly, that is the principle on which most projections are made—the globe is supposed to be made of glass and you are stationed inside it either at the centre, or on the side, or outside it altogether, close by, or at an immense distance off, and you are supposed to look through the glass and to see the meridians and parallels *projected* on to a paper beyond, or on a paper stretched between you and the globe.

25. Now we have not time to explain all the various ways in which people have endeavoured to represent the surface of the globe on a flat paper: it would be very difficult to describe them so that they would be understood, and if understood, it might hardly be worth the trouble. We will therefore confine ourselves to the two most commonly employed.

26. The world in hemispheres, which is found at the beginning of most atlases, is drawn on what is called the **globular projection**, which was the dis-

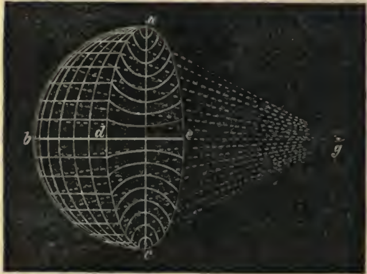

Fig. 3.

covery of Philippe de la Hire (1640–1718). In this you are supposed to be standing outside the globe, at a certain moderate *distance from it, and to be looking through at the inside of the opposite half; and the paper, or "plane of projection" as it is called, is supposed to be stretched across the half at which you are looking, like the parchment across a kettledrum.

27. Here *abc* is half of such a hollow glass globe, with its meridians and parallels drawn upon it. *g* is the place of your eye, and *adce* is the opening of the half globe, or the plane of projection. I have drawn the parallels on the plane of projection as they would appear to your eye at *g*, when looking at them on the inside of the globe; the meridians are not put in, as they would crowd the figure too much. But when both parallels and meridians are fully drawn on the plane of projection, or the parchment as we called it, they have this appearance :—

Fig. 4.

28. The meridians are all the same distance apart,

* Accurately stated, the distance of the point of sight from the sphere = (radius of Great Circle) × sin. 45°.

and so are the parallels when measured along the central meridian; but as they get nearer the outside of the map you observe that the parallels become wider apart, and therefore the map is distorted at the edges, and the countries have not quite the same shape as they have on the globe. Still you get on the whole a fair idea of the general relation and proportions of all the countries in one half of the surface of the earth. For this reason, and because the globular projection is easy to make, it has been gradually adopted for the general map of the world in atlases.

29. In these maps the meridians and parallels are curved lines, and therefore the shortest line between any two points on the globe must be a curve on the map. In maps of the land and for use by landsmen this is of no great importance, because the distances between the various places are not very great; but in charts which are used by seamen for working their course at sea it becomes a great practical inconvenience. A captain who has to navigate his ship say from Bristol to Charleston is naturally anxious to sail in the right direction between the two points. But on the maps we have hitherto described a straight line is not the direct line. To be a direct line it must be a curve—if you can understand that—because both meridians and parallels are curved. The direct line between two places on the same parallel or the same meridian would be easy to follow, as it would be merely the curve of the parallel or the meridian. But suppose the two places to be many degrees apart both in latitude and longitude, like Ceylon and the Cape of Good Hope, you would find that the line to be pursued was a very complicated curve, which few sailors could be expected to lay down correctly.

30. This difficulty became a very serious one when America was discovered and long voyages began to be taken, and to meet it a projection was invented by a Flemish mathematician called Mercator, in 1556, and perfected by Edward Wright, an Englishman, in 1594, which is not only very clever, but has perfectly answered its purpose. In this method you may suppose the sphere to be enclosed in an upright cylinder or hollow roll of paper, with the point of sight in the centre of the sphere.

31. Here *enrs* is the glass globe, with its North and South Poles, Equator, and parallels. The meridians are not drawn because they would only confuse us. *abcd* is the roll of paper wrapped round the globe. Now if you suppose a small bright light to be placed at the centre, it will shine through the globe and will throw the shadows of the parallels on to the roll of paper, as you see them in the diagram—10 will be close by, 20 will be a little farther off, and 30 farther off still. After that the shadows begin to spread very much, as you see; and if you compare the distance between 50 and 60, or 60 and 70, on the globe and on the paper, you will see how much they have widened out. The dis-

Fig. 5.

tance between 70 and 80 would be much more than that between 60 and 70, and the shadow of 90 (that is, the Pole) would of course go up through the end of the roll, and never be caught at all.

I have shewn you only the upper hemisphere, but the lower one would be exactly like it, reversed. As for the meridians, they need no diagram, for if you think about it you will see that their shadows must be equi-distant straight lines, running straight up and down the roll.

32. When the roll is unwrapt, supposing the shadows to remain fixed on the paper, it will have this appearence :—

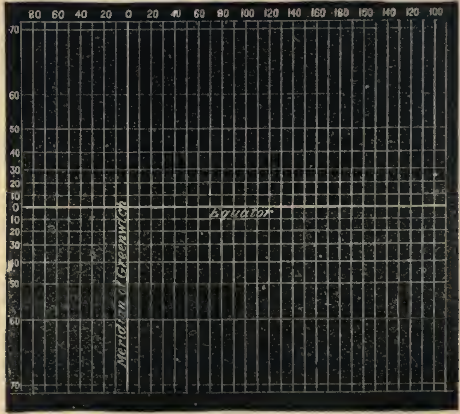

Fig. 6.

33. Accordingly in a Mercator's map the size of the countries at the north and south is out of proportion to those near the Equator. For instance, Iceland looks nearly as large as Borneo, and Greenland as South America, though Iceland is only 200 miles from north to south, and Borneo nearly 700, while Greenland is 1,400 miles and South America about 4,000. They keep their shape, but are very much too big, and therefore you must be on your guard in a Mercator's map not to be deceived by the apparent size of countries near the Poles. But still for the sailor's purposes Mercator's map is very convenient. North and south are always straight up and down, and east and west straight across. All the meridians are parallel, and all the parallels are parallel too. The most ignorant sailor can lay down his course without calculation. In fact the invention of this map has been justly called one of the most remarkable and useful events of the sixteenth century. And why? because it enables common unlearned people to do easily and correctly what only clever learned people could have done without it.

34. Hitherto we have spoken only of general maps, in which the whole world is got on to one or two sheets, and where a great distance like 100 miles is represented by half an inch or an inch. But maps are wanted for marching armies, selling properties, laying out railways, &c., and for these great detail is required; not only the general form of the coast, or the principal towns and roads, but every cottage and hedge, and lane and clump, must be exactly in its place. Now for doing this a different method is employed from that which we have yet spoken of. The latitudes and longitudes of the principal points

are found, and then the smaller ones are filled-in by the surveyors by a method called **triangulation,** because it is done by triangles, which I need not describe to you. It is also called a **trigonometrical survey** because the triangles are calculated by a branch of mathematics called trigonometry.

35. Here is a bit of what is called the Ordnance Survey of England, made in this way, on an **inch scale,** that is a scale of one inch to a mile, where each inch on the map represents a mile on the ground, half inch, half a mile, and so on.

Fig. 7.

36. The **scale** is, you see, the proportion between the size of the map and the size of the piece of ground which it represents; a **small scale** means that the map is small in proportion to the ground, and a **large scale** that it is larger in proportion.

Therefore, in speaking of it, it is as well to name the proportion itself—the number of times which the one will go into the other. The inch scale is thus called $\frac{1}{63360}$ because there are 63360 inches in one statute mile, and a mile on the map is one sixty-three-thousand-three-hundred-and-sixtieth part of a mile on the ground. Ordnance maps are made to other scales, even as large as 10 feet 6 inches to a mile, or $\frac{1}{500}$th part of the original ground. At the end of the book you will find a table of the scales in use.

37. Maps of the world or of large countries do not have scales marked on them, for, as I explained, they would be incorrect, except near the centre of the map. In the hemispheres (§28) you remember the parallels widen out towards the outside of the map, and appear to be farther apart than at their centre, though they are really parallel. And in Mercator's map (§32) the meridians are parallel instead of sloping together; and the parallels, though drawn parallel, do really become vastly wider apart as they near the Poles.

38. In a map for use in business or common life there must be no such uncertainties. On the inch map an inch must be a mile exactly, whether at the outside of the sheet, or in the middle, and measuring either north and south, or east and west. But you will remember that in each of the projections the centre of the map was accurate, and that it was only at the outsides, at long distances from the centre, that it was distorted. And as a projection may be made with any spot in the world as its centre, and the maps we are speaking of do not cover more than a few miles each way, there is no practical difficulty in obtaining all the accuracy that is wanted.

39. I asked you before if you could **read a map.** Like reading a book, it is only to be done by practice, but I can perhaps give you some useful hints.

(1) Before you begin **get the scale well into your mind.** A map is not a mere picture, and your object in looking at it is to get information; therefore, first of all, look carefully to see how much the scale is, how many miles there are to an inch, or you will have no true sense of distance.

(2) Next look at the **character of the ground** and the **height of the hills.** The slopes of the roads, the fall of the streams, the nature of the lakes and ponds, all depend on these things; therefore learn to interpret them with certainty. Now the rise and fall of ground is shewn in two ways—either by dark or light shading, according to the slope, or by **contours.**

Fig. 8.

Contours are lines which mark the same level all over the ground. Here is a map of a hill with contours, each 50 feet above or below the other. Each line is strictly level round the hill, and is as if a flood had risen by steps of 50 feet at a time, and had left its mark at each successive step. Where the contours spread out the ground is flatter, and where they crowd together the ground is steep, and knowing that they are 50 feet below one another, you can easily tell the height of any part above or below another part, and therefore the slope of the hill. The other method is by what are termed **hachures.** In this method, the thicker the lines, and the

Fig. 9.

closer they are together, the steeper is the ground; and the waterpartings and crests of the slopes should be traceable by the junction of the lines representing the two slopes. Each method has its *advantages; the hachures are much the more effective, and the alterations of slope can be beautifully traced, but it is impossible to infer the actual height of the inequalities from them. Contours, on the other hand, are

* A thoroughly satisfactory example of the drawing and shading of mountains, showing how far, even on a very small scale, minute features may be brought out, is furnished by the maps in the "Sketch of the Mountains and River-basins of India," by Mr. Trelawney Saunders (Stanford, 1870). Another on a larger scale by the same geographer is the map of "Jerusalem, Ancient and Modern," in the "Historical Atlas of Ancient Geography" (Murray, 1873).

much less striking to look at. They do not give the look of the ground, but they tell you exactly what the height and slope of it are. Shading is sometimes done with lines which look like contours, but are not really so; and this is misleading.

(3) There are many smaller signs which will give information if you know how to read them. In the Ordnance maps you can tell whether a road or railway is in cutting or in embankment; that is to say, whether it is below the surface of the country, or raised above it, since the two are represented differently. In fact so complete are these maps that you can distinguish turnpike roads, cross roads, footpaths, canals, and lines of telegraph. (See the list on page 126.)

40. We have been speaking of maps to a tolerably large scale. A map of a continent or country is necessarily to a smaller scale, and such full details as those just named cannot be got in, but a faithful representation of the general face of the land ought to be given — the valleys and ravines; the waterpartings; the watersheds gradually scored deeper and deeper with streams; the rise of the plateaus from the plains, and their flat tops; the gradual or sudden slopes of the hills—we ought to be able on a good map to see such general features of the country, as well as the positions of the places. And on such a map as that of Palestine in the *Historical Atlas of Ancient Geography*, all this is evident enough.

41. Before leaving this part of the subject there are one or two other things to mention. On looking again at the globe there are some lines which we have not yet noticed—the **tropics of Cancer and Capricorn,** and the **Arctic and Antarctic circles.**

42. The Tropics are two parallels of latitude—Cancer 23° 28′ north of the Equator, and Capricorn 23° 28′ south of it. At every spot on the belt of the earth's surface between those two parallels, on two days in the year the sun stands right over head at mid-day. Below the tropic of Capricorn, and above that of Cancer, he never stands right over-head, at any place, on any day in the year. Why this is you will find in the *Primer of Astronomy*. They are called tropics from a Greek word meaning to turn, because at those lines the sun seems to reach one side of his path and turn back to the other. The space between them is often called "the tropics," and a country there is called a "tropical country."

43. The Arctic and Antarctic circles are each the same distance (23° 28′) from the North and South Poles that the tropics are from the Equator. The Arctic circle is 66° 32′ N., and the Antarctic one 66° 32′ S. lat. At every spot within these there is at least one day in the year in which the sun remains in sight for the whole 24 hours, and at least one day in which he is out of sight for the whole 24 hours. Thus at the Arctic circle, on June 21st, he is visible for the whole 24 hours, and on Dec. 21st he does not appear above the horizon at all. At the Pole he remains out of sight below the horizon from Sept. 23rd to March 21st, and from that day till Sept. 23rd again, he is in sight both day and night, mounting by June 24th to the height of 23° 28′ above the horizon. The North Cape is in lat. 70° 10′, or 2½ degrees within the Arctic circle, and by joining one of Cook's tours you may go there next summer, and see for yourself the "midsummer, midnight, Norway sun set into sunrise" as the poet says.

44. Between these tropics and circles lie the **zones** or belts, into which the surface of the earth was for long divided by geographers. There are five of them. (1) The Torrid Zone, including all the space between the tropic of Cancer on the north, and the tropic of Capricorn on the south. Within this space, 46° 56′ wide from south to north, we have seen that the noonday sun stands vertical overhead at every spot twice in every year. (2) The two Temperate Zones, north and south. They reach from the tropic of Cancer to the Arctic circle, and from the tropic of Capricorn to the Antarctic circle. Each is 43° 4′ wide from north to south, and in each the sun is never vertical, but on the other hand there is always a day and a night—that is to say, the sun rises and sets in each 24 hours throughout the year. (3) The two Frigid Zones occupy the remaining space. They are each 23° 28′ from the circle to the Pole, or 46° 56′ from circle to circle, measuring over the Pole to the other side; and in each, as already explained, during a part of the year the sun never rises, and during a part of it he never sets. So much for the tropics and zones.

45. Mercator's map, you recollect, enabled the sailor to mark his course as a straight line. But having got this, and the correct latitude and longitude, there is still another thing wanted. The map, we will say, tells the sailor to sail north-east, that is, half way between north and east; but how is he to know where north and east are? For the north he has to look at the Pole Star, which stands above the North Pole, and east is roughly where the sun is at six in the morning. But suppose it is cloudy or foggy, and neither sun nor stars can be seen; or

suppose even that it is fine, how is he to maintain through the day the course which he was able to take when he saw the Pole Star, or the sun rising?

46. This he is able to do by the **mariner's compass,** or needle, which is a straight steel magnet, balanced on its middle in a box so hung as to be always level however the ship may be moving. Being a magnet, the needle always points towards the north, and as it carries above it a round card divided into 32 parts or "points," you will see that the head of the ship can be kept in any direction that the captain likes. The ship is now being steered in the

Fig. 10.

direction of N.N.E., and if, on looking at his map, the captain saw that he ought to go N.E. by N., he would alter the helm so that the centre line of the ship should agree with that point, and all would be right.

47. The compass was invented in the 12th or 13th century, no one knows by whom. Before its discovery ships crept about close to land, or if they ventured out, as St. Paul's ship did, for an open course of 5 or 600 miles, were at once in the greatest uncertainty when the sun and stars were hid.

48. I said that the needle pointed *towards* the north, but it does not always point exactly *to* it. In fact there are only two lines on the earth's surface along which the needle does point to the true north, and neither of the two has any connection with parallels or meridians, but seems to cross them at haphazard. One of them sweeps up from the Antarctic circle, enters the east coast of S. America, in S. lat. 24°, a little south of Rio Janeiro, leaves it again at Cayenne, north of the mouth of the Amazons, crosses the Atlantic outside the West Indian islands, enters North America near Cape Hatteras, and runs to a point north-west of Hudson's Bay. The other line lies nearly opposite across the world, and is much more irregular in its course. It too comes up from the Antarctic circle, and enters South Australia in E. long. 129°, S. lat. 32°, in the Australian Bight. It leaves it again in King's Sound, lat. 17° S., and long. 123° E., and taking a sudden bend to the west, passes outside of Java, Sumatra, and the Malabar coast, enters the continent of Asia in E. long. 60°, runs to the west of the Caspian, passes between lakes Ladoga and Onega, and enters the Arctic Sea near the North Cape.

49. Along these lines there is no **variation of the compass,** but the needle points straight to the true north; and as you leave them on either side it varies. To the east of them it points to the west of the true north, and to the west of them it points east of the true north, more and more as you forsake the lines of no variation. At the south of Greenland the variation is 50 degrees West, and if you wanted to steer N.N.E. through Smith's Sound, as the Arctic Expedition did, you would have to set the ship's head West by North. (Look at the Compass, fig. 10.) The variation at London is 19° 26′ West, at Cork 24° West, and so on. The lines of variation all over the world are marked on the Admiralty charts, so that no mistake need be made.

50. This variation is not always the same at the same place, but changes year by year or day by day. It was first noticed by Columbus on Sept. 13, 1492. In the year 1580 the variation at London was 11° 15′ East. In 1660 it had decreased to nothing, and the needle at London then stood true; but it immediately began to vary on the other side, and increased till 1818, when it reached a limit of 24° 30′ West; then it began to decrease, and now the variation there is 19° 26′ West.

51. The lines of variation come together at two places. One is north of Hudson's Bay, near Port Kennedy, in 70° N. lat., 97° W. long. A second is in the Antarctic regions, 73° S. lat., 147° E. long. These points are called magnetic poles, and if you take the compass-needle to one of them it will behave very strangely. It will not remain level, but will dip, and stand straight up and down, the north end down and the south straight in the air; also, if it is prevented

from doing this, and obliged to remain level, it will turn equally well to all points, just as a common piece of steel, not a magnet, would do; in fact over the magnetic pole the north is nothing to the magnet. The variation of the needle east or west is called its *declination*: the dip up and down, is called its *inclination.*

52. **Time.** Another remark before we close this part of the Primer. We have seen that the circumference of the earth is divided into 360 parts or degrees. As it goes round on its axis once in 24 hours, its surface moves at the rate of 15 degrees an hour, since $15 \times 24 = 360$. I am not speaking now of the movement of the earth round the sun, but of its **motion on its axis** only—its **rotation**, not its *revolution.* The sun is standing still at a distance, and the earth spins round once in 24 hours from west to east; and thus every place comes into view of the sun—which is **sunrise**; arrives right opposite him—which is **noonday**; and loses sight of him again—which is **sunset.** But move a short distance on either side of your own place, and each of these events will happen sooner or later than before. If you move to the East, sooner; if to the West, later. The difference made by moving one minute of longitude would be 4 seconds of time, and by one degree of longitude 4 minutes of time.

53. And this explains why, when you go from the place in which you live to one east of it, your watch seems to lose. It is not that your watch loses, but that you have arrived at a place where the sun comes into view of the earth, and comes to 12 o'clock, sooner than where you usually live. Suppose you go from London to Hamburg. Hamburg is

east of London by 10 degrees of longitude. Now the earth turns once round, that is through 360 degrees of longitude, in 24 hours; and as from London to Hamburg is 10 degrees, when you are at Hamburg you are one 36th part of 24 hours, or 40 minutes, nearer the sun than in London; that is to say, the earth arrives at sunrise and at 12 o'clock, 40 minutes sooner in Hamburg than it does in London. But your watch keeps London time, and therefore, when it is 12 o'clock at Hamburg, your watch is 11.20, because at that moment it is 11.20 at London. In other words, London will have to travel 40 minutes farther east before it comes opposite the sun for 12 o'clock. If when it is 12 at Hamburg they were to telegraph the time from London, it would be 11.20; and if when it is 12 at London they were to telegraph to you from Hamburg, it would be 12.40 there—Hamburg would have passed 12 o'clock, or the meridian line, by 40 minutes.

54. Go to a place west of London and the opposite happens. Take New York, which is 75° West longitude. Now 75 times 4 minutes is 300 minutes, or 5 hours; that is to say, 5 hours after it has struck 12 o'clock at London, New York will have come whirling round to the same place at which London was 5 hours before, and will arrive opposite the sun, and have its 12 o'clock; and meantime London will have gone on with its day, and its clocks will be striking 5 in the afternoon. And this accounts for the fact that telegraphs arrive in New York from London apparently before the hour at which they are sent off. Thus, say the Boat-race is won by Oxford at 1.35 P.M. The news is telegraphed to New York, and arrives there, we'll say, by 2 London time. But at 2 London time

it is only 9 New York time (5 hours earlier), so that New York actually hears of the event 4 hours and 25 minutes before the hour at which it happened !

55. After the railways were made it was found very inconvenient to have one time in London and another at Exeter or Birmingham, and so in all common matters the towns of England sink their own correct time, and the clocks are set to that of London. Thus a train leaving London at 9 arrives at Bristol in 4 hours, and finds the clocks there 1, exactly as they are in London; though if the clocks told the correct time they would show 12.50, Bristol being 2° 34′ west of London, equivalent to rather more than 10 minutes of time. And communication will increase until the same thing that has been done in England will have to be done outside of it, and sooner or later all countries will have to keep London time.

56. As you go farther and farther round the world, the difference between the hour where you are and the hour at Greenwich will increase till it reaches 12 hours, and if you sail on till you get back to Greenwich again you will have gained or lost 24 hours, according as you sailed east or west—gained if you went east by the Suez Canal, lost if you went west by America. In the first case, when you got back, if it were Tuesday on board the ship, it would be Monday on the newspapers in London; in the second case, it would be Tuesday on board and Wednesday on the newspapers. To correct this the log or journal of the ship is always altered when it arrives at the meridian of 180° (half-way round the world from London), and a day is added or dropt in the reckoning as she has sailed East or West. But the old sailors were not always careful to do this, and some curious things happened in consequence. When

Captain Basil Hall got to Manilla (120° E. long.) he found that their Sunday was his Monday. At Tahiti the reverse has happened, and they keep Sunday on a Saturday. "At Sitka in Russian America (W. long. 136°) half the people are Russians who have arrived from Russia across Asia, and half are Americans who have come from the United States. Hence when it is Sunday with the Russians it is Saturday with the Americans; and the Russians are busy on Monday, while the Americans are in church on Sunday, to the great interruption of business." (See Clarke's *Geographical Reader.*)

57. Now you can understand what I meant when I said (§ 19) that the traveller looked at his chronometer to find the longitude. His chronometer is set to Greenwich time, and always tells Greenwich time, and therefore if he finds by his observations that at the place he is at it is 12 o'clock when his chronometer is 3, he will know that he is three hours west of Greenwich, and 3 hours × 15 degrees = 45 degrees East longitude. So important is this simple method of finding the longitude that in 1714 our Government offered £30,000 for a chronometer which would tell it *within even so great a distance as thirty miles!*

58. Once more before we leave our globe for the earth itself, see how these scientific terms have worked their way into common speech. You have often heard the expression—"angle of ninety degrees;" "angle of forty-five." You remember that each meridian is divided into 360 degrees over its whole length. If, therefore, from the Equator over the Pole, round by the Equator and South Pole to the starting-point again was 360 degrees, it stands to

reason that from the Equator to the Pole will be one quarter of that, or 90 degrees. From *e* to *n* is

Fig. 11.

90 degrees; and the angle at *c*, the angle *ecn*, which is opposite that opening of 90 degrees, is called an "angle of 90 degrees," or a "right angle,"—that which a stick makes with the floor when you stand it quite upright. And an angle of 45 degrees, *wcd*, is exactly half the angle of 90°—half way between being level and being upright.

THE EARTH.

59. We will now leave the lines and figures on the globe, and go to the Earth itself, and the land and water upon it.

60. In the foregoing account we have spoken of the earth as a sphere, or an exactly round ball. But this, though practically true for our purpose then, is not strictly correct, for the earth **is not exactly round.** You can see it is not. The mere roughness of the fields and roads and hills, not to speak of the high mountains or the depths of the sea, all tell you that it is not exactly round. On so big a ball as the earth, however, these things do not count for much. The

highest mountain is not quite 30,000 feet high, and the deepest place known in the sea is hardly so deep. Add these together and you have 60,000 feet, and what is 60 thousand feet to a vast ball like the earth, which is 42 million feet through? it is only like the little roughnesses on the rind of a smooth orange, or the tiny pits and dots on the shell of an ostrich's egg. In proportion to an orange the 60 thousand feet would be **the thickness of the paper on which this page is printed.** These, therefore, may go for nothing.

61. But there are other things, not mere roughnesses, but actual differences in the shape or **figure** of the earth. The earth has been measured—through, round, and across; they are still measuring it, and always coming nearer the truth; but at present what we know of its figure is that round the Equator it is not quite a true circle, but is very, very **slightly oval.** Its diameter in *one direction is 7,926⅔ statute miles, and in another 7,924¼ miles, a difference of two miles in nearly 8,000. Then again, from Pole to Pole the distance is 7,899 statute miles, so that the diameter there is less than that at the Equator by some 26 miles, and the earth is consequently that much bigger round the Equator than it is round the Poles; a shape which is called an **oblate spheroid.** Such, as far as we know at present, are the differences in the figure of the earth from what it would be if it were round like a billiard-ball.

62. It has been sometimes said that the difference in size between the Equator and the Poles has come from the earth having spun round while it was in a

* Diameter at 15° 34′ E. long. = 41,852,700 feet
Ditto at 105° 34′ E. long. = 41,839,944 do.
Ditto at Poles . . . . = 41,706,858 do.

soft state, bulging out as a ball of clay might bulge if put on a wire and made to spin very fast; but we know too little of the history of the earth at those early times to allow us to say if the difference in shape arose from that cause or not. But two things I may tell you about it. 1st. That thin band of 13 miles thick on a ball of 8,000, is enough to give the sun and moon such a purchase on the earth that they are gradually pulling its axis round and altering its attitude with regard to the stars. This is called "the precession of the equinoxes," and it may cause in time a great change in climate, and cover England with perpetual ice. 2nd. But for that trivial flattening at the Poles and projection at the Equator, the sea would not be distributed over the surface of the earth as it is, but would be gathered round the Equator, leaving a great continent of dry land at each Pole.

63. I cannot attempt to give you any idea of the way in which the earth is measured. It is enough for us to know that the distances have been exactly measured, and that they are as I have stated them. But notwithstanding what I said of the roughnesses of the earth being comparatively so small, you may naturally ask how so uneven a body can be measured as if it were a smooth ball; and if it will not make a great difference in the length of the diameter if it is measured to the top of a mountain or to the bottom of the sea. And your question is quite right. Such measurements must be taken most exactly to be of use, and therefore the level of the sea, which is believed to be about half way between the tops of the mountains and the bottom of the ocean, is chosen as the surface of the world, and the measurements given above are those of an oblate spheroid as large as

the earth would be if the dry land were removed, and the ocean covered everything.

64. But you may still say, "The level of the sea? The sea is always rising or falling, and never at one level." Well, then, the level which is taken in all such calculations, in the Ordnance Survey of England, is the average level between high and low water at Liverpool; and the diameter and circumference of the earth are the diameter and circumference of a ball covered with a smooth surface starting at that height. For many other purposes the level of high-water at London Bridge, or, as it is called, *Trinity high-water mark, is taken.

65. Now, on looking at the globe, or a map of the world, the first thing that must strike every one is **how much more water there is on it than dry land.** The whole surface is 197 millions of square miles; but the dry land—that is to say, those parts of the earth which are high enough to stand up out of the water—is only at most 52 millions, leaving 145 millions for the ocean. In other words, the land is about one-quarter of the whole surface, and the ocean about three-quarters.

66. This is the first thing that strikes us. The second is, how very unequally the land is arranged. Instead of being spread evenly all over the surface, it is collected together, much more to the north than to the south, and to the east than to the west. There are 38 million square miles of land above the Equator, to 13½ below it; in other words, nearly three times as much. Strangely enough, London is very nearly in the centre of this mass of land; and

* Trinity high-water mark. So called from the Trinity House, a corporation which has charge of pilots, lighthouses, buoys, and other nautical matters.

Fig. 12.

Fig. 13.

placing ourselves over its position on the globe (as in fig. 12), we have nine-tenths of the entire land of the world in view below us. In like manner, New Zealand, which is opposite England on the other side of the world, is in the centre of the ocean hemisphere, and has a waste of water on all sides of it. There is land round the South Pole, estimated at nearly double the size of Europe. But of this next to nothing is known, it is enclosed in eternal ice, without men and women, apparently without life, and all but inaccessible. The difference between the land east of London and the land west of it is also very great, as may be seen on any general map of the World; they do not at all balance, but there are 36 million square miles to the east, and only 15½ to the west.

67. The third thing that will strike us is that, though the mass of the land is thus collected in the northern part of the world, it seems to be everywhere **reaching down towards the south.** South America, Africa, and Australia stretch out like gigantic fingers and thumb towards the Southern Pole; and the same on all sides farther north, for India, Malacca, Kamschatka, Corea, Florida, and even Sweden, Norway, and Greenland, all seem to be pointing down in the same southward direction.

68. Returning to the dry land in the Northern Hemisphere, and trying to look at it as if we had never seen or heard of it before, we shall see that it consists of **two great continents or masses,** one to the east and one to the west. For Europe and Asia are absolutely one continuous tract, with Australasia as its outlying islands; and Africa—though the connection has been snapt at Gibraltar and Sicily and the Straits of Bab-el-Mandeb, and again within the

last ten years at Suez—is still really part and parcel of the rest. Thus the Old World, looked at as mere land, and apart from political or historical divisions, is one great continent. And the New World, too, on the western side of the globe, is still one continent, though its upper and lower portions are held together by a very narrow strip of land.

69. We will now look more closely still at the two sides of the world, east and west, the Old World and the New, and see what strikes us about them.

70. In general direction **the Old World runs across the globe,** not up and down it. From Cape de Verde, the most westerly point of Africa, to the most eastern cape of Asia, the land stretches without interruption for 174 degrees of longitude, nearly half the circuit of the world. And its structure or framework lies in the same direction. Through the entire length of this great continent runs a line of mountains and high ground, which, notwithstanding a few breaks in its European portion, forms an almost continuous wall or chain for the whole distance, rises as it goes eastward, attains an enormous height and mass, and seems to gird, and hem in, and consolidate the vast continent around and above it. Beginning on the shores of the Atlantic in the Pyrenees and Atlas, it continues through the Alps and Carpathians, the Caucasus and the range of El Burz, to the Hindoo Koosh and the high plateau of Pamìr, called "the roof of the world," which stands like a huge fortress, 15,000 feet high, to bar the direct road between east and west. Thence it passes to the still higher tracts of Tibet, great plains exceeding in height the highest summits of the Alps, enclosed between the lofty ramparts of the Himalayas on the south and the Kuen-lun mountains on the north; and

Fig. 14.

thence the mountain wall is prolonged in the ranges of Yuen-ling, In-shan, and Stanovoi, till it passes finally to the Pacific Ocean at Behring's Strait.

71. Such is the backbone of the great continent of the Old World, and like a true backbone it sends out its ribs and flanks on either side of it. The sierras of Spain, the Apennines, the Alps of Turkey and Greece, the Taurus, Zagros, and Suleiman mountains, the Indian Ghats, and Burman ranges, on the south; the Cevennes, the Jura, the Vosges, the Ural, on the north, form its ribs; while between and around these lie the flanks of lowland, such as India and Burmah, the Steppes, and the great plain of Central Europe and Northern Asia.

72. The **great plain** which lies to the north of this vast mountain barrier is a feature not less remarkable than itself. Beginning in the Midland Counties of England, it stretches over the whole width of the Old World, through the Netherlands, Prussia, Russia, and Siberia. The Ural mountains alone cross it, but they hardly alter its character—a wide, gently swelling, gently sloping plain, stretching from the mountains to the sea, drained by some of the largest rivers of the world, and exposed over a great part to a frightfully cold and inclement climate.

73. These plains and the mountain range have been of vast importance in the world's history. South of the mountains, in India, Mesopotamia, Greece, Italy, Spain, were the ancient seats of civilisation and wealth, an inviting climate and happy life; north of them, in the high plains, were cold, poverty, and barbarism, fierce hordes of wild and savage men. The Medes who took Babylon, the Scythians and Parthians who ravaged Palestine and Egypt, the Huns, Goths, and Vandals who

desolated Italy and Spain, the Turks who conquered both India and Greece, all descended from these lofty plains; and all entered the south, and passed from barbarism to civilisation, through the passes in this wall of mountains. In modern times this has been reversed. It is now we of the low warm countries who are penetrating into the high bleak ones. And one of the great geographical and commercial problems of the present day is to find means for bringing down the wool and minerals from the lofty plains of Tibet and Cashmere to the lowlands and the sea, in exchange for the cloth and the cutlery of Europe.

74. North of Tibet, and enclosed between it and the Altai mountains, which overlook the long plains of Siberia, stretch the savage deserts of Gobi and Mongolia, the home of the Mongols. West of these, and reaching from the foot of Pamìr to the Caspian, is a region which has played a most important part in history—the great district of Turkestan, the original seat of the Turks and many other European nations. That immense district, with that of Tibet—which is distinct from Turkestan, though agreeing with it in this one feature—has been called the great **continental** region, or region of "continental" streams, because its waters are mostly "contained" within itself. Tibet is so high, so far inland, and so enclosed, that a large part of its rivers cannot get to the sea, and have to empty themselves into lakes. Turkestan, however, is as low as Tibet is high. From the heights of Pamìr, and the "roof of the world," the mountains suddenly descend, and two immense rivers, the Amoo Daria and Sir Daria (Oxus and Jaxartes) rush down to the plains 14,000 feet below. But not to reach the ocean, though from a different cause than before. While Tibet is

too lofty and too much shut in, Turkestan is too low, and the rivers just mentioned and the other streams of the plains of Turkestan flow either into the Sea of Aral, which is a few feet above the ocean, or into the Caspian, which is a few feet below it. In fact the "continental" region penetrates far into Europe, and embraces half of Russia; for the river Volga, the largest of European rivers, empties itself into the Caspian and does not come near the ocean. Thus this region, notwithstanding a difference of many thousand feet in the level of its two portions, has in both the characteristic that its waters are all contained within itself. It stretches from within a very few miles of Petersburg to the neighbourhood of the Yellow Sea, and contains fully two million square miles.

75. If we now turn to **the New World** we shall find that in many respects it forms a striking contrast to the Old one. Instead of running in the general direction of the parallels of latitude, east and west, America stretches almost directly north and south, along the meridians of longitude; and instead of being compact and massive, like the principal part of the Old World, it is long and straggling, with a large extent of sea-coast, and with a very near approach to a separation between its two portions. Instead of its centre being occupied by a great mass of highlands, guarded by mountains all but impossible to climb, and when climbed cold, bleak, barren, and desert, contained within itself and shut off from the rest of creation—the mountains of America are mostly ranged close to one of its coasts, and its lowlands abound in splendid rivers, which form natural roads to every part of the country, and make the vast continents of South and North America in great part accessible from the

Fig. 15.

sea to steamers. Its remarkable features are its **mountains, plains,** and **rivers**—the mountains of huge height and great beauty, and containing more active volcanoes than any other range, the plains the largest and the rivers the most extensive that the world possesses.

76. It is the position of the mountains that first strikes the eye. In South America the **Andes**, as the mountains are called, run close to the western side of the continent—a continuous chain of 4,000 miles in length, often of double and triple parallel ridges, at a mean height of 11,000 feet, with great active volcanoes, and numerous peaks varying from 16,000 to 24,000 feet in height. At the Isthmus they are interrupted; but immediately start again, and under the name of the **Rocky mountains** run in the same northerly direction, though at a greater distance from the sea-coast, through the United States and British America, till they end on the shore of the Arctic Ocean, after an almost unbroken course of more than 8,000 miles. Such a range, so vast, so lofty, so precipitous, so volcanic, so regular, is unparalleled in the world. But it is even more astonishing when taken in connection with the enormous rivers to which it gives rise.

77. The rivers of America are the largest in the world, not only for their length and volume of water, but for the extent of their basins. (§ 200.) In South America three rivers, the Orinoco, the Amazons, and the La Plata, take three-quarters of the whole drainage of the country to the Atlantic, and each of these draws a large amount of its supply from the flanks of the Andes. Thus the curious sight is presented of rivers rising within a short distance of one ocean,

and being compelled to traverse thousands of miles to cast themselves into another. In this respect they find a likeness, though on a smaller scale, in the Po; which, while it rises in the maritime Alps near the Gulf of Genoa, is compelled to cross the whole of the plains of Lombardy to discharge itself into the opposite sea of the Adriatic. So also in South-eastern Australia, the Murray river rises behind Brisbane, within 100 miles of the Pacific, and yet runs 1,000 miles, to enter the Southern Ocean at Adelaide. In North America the Mississippi and Missouri receive much of their drainage from the Rocky mountains, and run a course even longer than that of the Amazons; but the picture is not so startling as that in South America, because the Rocky mountains stretch much farther from the west coast than the Andes do, and because the rivers do not cross the continent so directly, but derive much of their water from the Alleghany mountains on the east coast, and the low watershed about Lake Superior in the north. But to return to South America. A great part of it may be roughly described as an alluvial plain of more than 2,000 miles long, sloping very gently up from the Atlantic to a prodigious ridge of mountains on the extreme edge of its farther side. True the centre of the country is occupied by an important plateau, which gives birth to other considerable rivers, but it sinks into insignificance when measured against the Andes, and does not interfere with the general truth of the rough description just given.

78. The New World has its "continental" districts, but on a smaller scale than that of Central Asia. One is in the bosom of the Bolivian Andes, a plateau of about 1,100 miles in length by 120 wide, and from

12 to 13,000 feet high, where there is a large lake called Titicaca, and other lakes, which receive the rivers of the plateau. Another is the Great Salt Lake district of Utah in North America, between the Rocky mountains and the Sierra Nevada, 500 miles by 280, and from 4,000 to 5,000 feet high, the waters of which have no outlet and form a series of salt lakes.

79. But the most remarkable lakes of America are the fresh water ones of the Northern Continent, which have no parallel elsewhere. They are scattered more or less over the whole of British America, chiefly in its central and southern portions, on the northern slopes of the upper waterparting of the Missouri and Mississippi; and they form the largest mass of fresh water on the surface of the earth. In the northern portion, the Hudson's Bay Territory, there are lakes of large area—such as Great Slave Lake, 12,000 square miles, Great Bear Lake, 10,000, Winnipeg, 9,000. But they are far surpassed by those somewhat farther south. These are five in number, each running into the other, and each lower than the last—Lake Superior, 627 feet above sea-level, Huron and Michigan 590, Erie 564, and Ontario 232, from which the river St. Lawrence leads direct into the Atlantic. Between Erie and Ontario are the Falls of Niagara. Lake Superior is the size of Ireland, and 900 feet deep. The depth of some of the others is still greater. They cover in all 94,000 square miles, and form nearly one-third of the basin of the St. Lawrence; their beds go down to 400 feet below the sea-level; and they contain more than half the fresh water of the globe.

80. But there are other points in which the New World is unlike the Old one.

The natural circumstances which make the most important and radical differences between continents or countries, and give one an advantage over another, independent of the energy of its inhabitants, are three :—

1. **Length and indentation of coast-line or seaboard.**

2. **Long, large, navigable rivers.**

3. **Good climate.**

Of these, **coast-line** means length of shore, with bays, gulfs, estuaries, and headlands; to shelter shipping, to be occupied with towns and villages, fisheries, ship-yards, harbours, docks, and industry and civilisation of all kinds, and to nurture the independence and love of adventure which are the virtues of sailors. **Rivers** mean easy communication with the interior, so that the productions of other countries may be sent up to the inland places, and those of the country itself brought down for export. And **good climate** means those natural conditions of heat and weather and health, without which it is not possible to use the two other advantages when you have got them.

81. Now looking at the world in the light of these three conditions, it is easy to see the difference between its different parts, and how the division of the Old World into three continents came about. For though, as we have already seen, the Old World is one great mass of land, yet when employed in the service of man it naturally divides itself into the well-known three portions of **Europe, Asia, and Africa.** Africa has in many parts a poor coast-line, few harbours, few rivers for its size, and much unhealthy climate; and with the exception of Egypt, Algeria, the Cape Colonies, and a few other places on the coast, the whole of that

immense expanse of land, 12 millions of square miles, abounding in rich resources, may be said to be given over to barbarism, idleness, and cruelty. The tse-tse fly, fatal to horses and cattle, is alone enough to prevent the spread of agriculture in certain districts. Egypt and the Cape owe their prosperity mainly to the Nile and the harbours of Simon's Bay and Algoa Bay. What might Africa not be at this moment if its vast bulk were pierced by a Baltic or a Mediterranean Sea, which would admit ships and commerce with their civilising influences to penetrate into its interior !

82. Of the mainland of **Asia**, India and China are the only fully peopled, industrious, prosperous portion. And why? because China has an indented coast-line with estuaries and harbours; and both have large, long, navigable rivers, and climates, which though not absolutely good are yet quite tolerable. On the other hand Arabia, with a rocky inaccessible sea-coast, and no rivers, is a desert. Persia is almost equally without means of access, and equally desert. The countries of Central Asia are cut off from the rest of the world by their height, and want of connection with the sea, and their severe climate; while the people of the vast plains of Siberia, one-fourth larger than the whole of Europe, watered by three of the noblest rivers in the world, have these advantages neutralised by the extreme cold, and, like the districts last mentioned, are wild and uncivilised, and mainly dependent on hunting or fishing and other casual modes of life. The population of Siberia is not as much as one inhabitant to a square mile.

83. With all this **Europe** is in happy contrast. In length of coast-line it is far better off than the other continents. For while Asia has but one mile of

coast to 533 square miles of surface, and Africa one to 420, Europe, with an area of 3,700,000 square miles, has 19,500 miles of coast, or one mile to every 190 square miles of surface, and out of the whole 19,500 not more than 3,000 are difficult of access. No natural circumstances more favourable to navi-

Fig. 16.

gation and commerce can be imagined than the deeply indented coasts of Asia Minor, and the Grecian Archipelago—where European commerce first fixed itself —Italy with its double seaboard and its three great adjacent islands, or the equally irregular outline of England, Scotland, and Ireland. Compare a coast like Greece (fig. 16) with that of Ceylon (fig. 17), which has few indentations, even if those few be important, and the inferiority of the latter to the former as a nurse of maritime life must be evident.

84. The rivers of Europe, though far behind those of Asia for size, are far before them for convenience and advantage. Spain is deficient in navigable streams, and suffers in consequence, but the Danube, the Rhine, the Seine, the Loire, the Elbe, the Po, and

Fig. 17.

the Vistula, with their hundreds of branches, form splendid roads, up and down which commerce pours its tides between the heart of the continent and the ocean, and, beyond the ocean, the ports and rivers of other countries. The Russian rivers are worthy of consideration by themselves, for their great size, their navigableness, and the flatness of the country which they drain; so gently swelling as to enable canals to be made between the rivers, by which boats can pass from the White Sea and the Baltic to the Caspian, the Black Sea, and thence to the Mediterranean. But pre-eminent above them all, in the true qualities of a useful civilising river, is the Thames, which, though smaller than any of those mentioned, surpasses every one for convenience and for the manner in which it is fitted to the requirements of commerce.

85. In **climate** Europe is equally fortunate. The line of permanent frost, or average temperature at freezing-point throughout the year, which includes a large part of Northern Asia, only touches Lapland and the north-east corner of Russia; while the line of 70° mean annual temperature sweeps just past its southern shores. It thus escapes both extremes. It has neither the long droughts nor the violent deluges of rain which afflict Asia and Africa, nor the typhoon winds and sudden cyclone waves which destroy so many thousands of people; everything is equable, steady, and beneficent. The ocean isolates it from the Polar regions, softens and equalises the temperature of its coasts; the Gulf Stream cherishes and moistens its western shores; while the great furnace of Africa is near enough to send its warmth across the Mediterranean to the countries opposite. **Commerce**—with all its evils, the grand instrument of civilisation in the world—if not European by birth is so by adoption. Here, as in its river, England is pre-eminent. What Europe is to Asia and Africa, Great Britain is to Europe. Trade, which began in Phœnicia, moved westward through the promontories and islands of Greece, through the lagoons of the Adriatic, and the creeks and harbours of the Riviera, through Spain and Holland, to arrive at last at our favoured isle; where no day is too hot and no day too cold for work, where business is never interrupted by frozen rivers, or destructive floods, or tremendous tempests, or any other of those operations of nature which must seriously injure the commerce even of other European countries.

86. Looked at in the light of their adaptation to man's necessities, we see, therefore, that the ancient

division of the Old World into the three continents of Europe, Asia, and Africa was a natural, necessary, and reasonable one.

87. And when we cross the ocean to the **New World,** which the ancients did not know, we find similar conditions leading to similar results. **South America,** as we have seen, has a splendid system of rivers; its natural productions are of great luxuriance and value; its coast-line is 16,500 miles to 6,800,000 square miles of surface—or 1 to 420; but it wants harbours, and the heat, the moisture, the inundation of the rivers, and the plague of insects and reptiles, prevent these advantages being enjoyed, and give it a population less in proportion to its size than even Persia or Arabia.

88. The conditions of Australia are in many respects equally unfavourable. Lying, as it does, between S. lat. 11° and 39°, the heat even on the sea-coast is often overpowering; the rainfall is small, and scorching winds and long droughts are frequent, though the climate is healthy. The mass of land is nearly as solid as that of Africa. The Gulf of Carpentaria is a fine inland sea; the harbours of Port Jackson and Port Philip are magnificent, and there are other inlets and estuaries, but a large part of the coast is very unsuited for navigation. The rivers are few, and with the exception of the Murray small and shallow. The Murray is 1,200 miles long, and drains a basin of more than 200,000 square miles—more than twice as much as England, Wales, and Scotland; but its entrance is closed by a bar, it has only two affluents of importance, and the other rivers are mostly mountain streams, rushing torrents in winter, and dry beds in summer, so that internal communication by those channels is

impossible. A great part of the centre seems to be a depressed basin, and to consist of a sandy, waterless, burning desert. And although this is being gradually encroached on, and may ultimately be reclaimed, it will be so by the energy of the British race working against great natural difficulties.

89. It is in **North America** that we find the nearest approach to the favourable conditions of Europe, making it practically a separate continent from South America. Its area is 8,600,000 square miles, and its coast-line 24,500 miles long, so that it has a mile of shore to each 350 miles of surface. It is true that about 7,000 miles of the coast are within the Arctic circle, and therefore useless for navigation, and the western coast, on the Pacific, is not much indented; but the eastern side, from Newfoundland to Cape Hatteras, is full of inlets, bays, outlying islands, peninsulas, and harbours, admirably fit for shipping. The rivers of North America are the largest in the world. The Mississippi and Missouri spread their countless arms over a basin twelve times the size of Great Britain. Some of their branches are mighty rivers, and the two main streams are navigable for more than 4,500 miles from the sea. The St. Lawrence, the Hudson, Susquehanna, Delaware, Potomac, and James, are fine navigable rivers, with large cities on their banks or at their mouths. In climate North America is less happy than England. Owing to the size of the continent, and the consequent distance of its interior from the sea, as well as its direct connection with the Arctic regions, the heat in summer and the cold in winter are greater than they are with us; and the enormous scale of the rivers exposes them to floods and other drawbacks which

would seriously interfere with commerce, but for the indomitable energy and activity of the people.

THE OCEAN.

90. So far for a general rough idea of the nature and position of the dry land of the world. About its various masses, round the peninsulas and headlands, into the bays and gulfs, and through the straits and passages, circulates the wide and ever-flowing **ocean**, filling up the deep hollows between the continents and islands, distributing warmth and life throughout, and affording a ready means of communication all over the world.

91. I have already said that it is estimated to cover 145 millions of square miles, about three times the surface of the land. This great body of water is one and undivided. True, Africa, South America, and Australia do, as we have seen, project down towards the South Pole, and hinder the waves from flowing straight on from east to west or west to east, but the waves make their way round these obstacles, and every particle of the surface water probably visits in turn every part of the ocean, and every nook and corner of the shore. Through Behring's Strait and Baffin's Bay and the seas of Greenland and Kara, currents are constantly running to interchange the warm water of the Equator with the cold water of the Poles. Even in such enclosed places as the Baltic, the Red Sea, and the Mediterranean, there is always a current running in and another current running out.

92. But though all one great body of water, the sea naturally divides itself on the map into five main

portions—the Atlantic, the Pacific, the Indian, the Arctic, and the Antarctic Oceans.

93. The **Atlantic** is the one which most nearly concerns us. It forms the channel between Europe and Africa on the one hand, and America on the other. In general form it is long and winding, the coasts on one side curiously answering in outline to those on the other. From north to south, from Iceland to Cape Horn, it is 8,000 miles long. Its northern portion, say between Lisbon and New York, is 3,400 miles wide. Between Sierra Leone on the coast of Africa and the opposite shoulder of South America it narrows to less than 1,800, and then widens southward, until from the Cape of Good Hope to Monte Video it is 4,300 miles.

94. Now there are two things which in the main give an ocean importance in the world, and an advantage over another ocean, and these two are length of coast-line and extent of basin, that is of rivers which run into it (see § 200) ; both add to its commerce, to the number of ships which sail upon it, and of people who live by it ; and both of these the Atlantic has got to a far larger extent than either of the other oceans. In addition to the long smooth shores of Western Africa and Eastern South America, all the indentations and windings of the North American coast, the Caribbean Sea and Gulf of Mexico, the bays and inlets along the shores of the United States, Nova Scotia, Newfoundland, the Gulf of St. Lawrence, all immensely increase the length of the coast, and the opportunity for shipping ; even Hudson's Bay and Strait may possibly be some day or other full of inhabitants. In Europe the coasts which lie open to the Atlantic are themselves indented and winding

enough, and full of harbours, refuges, and estuaries; but add to these the extra recesses, hidden, as it were, in the background, of the Mediterranean, Adriatic, and Black Sea, the Baltic, Gulf of Finland, and Gulf of Bothnia, and you more than double the length. The coast-line of the Atlantic on the whole is calculated at about 55,000 English miles.

95. Closely connected with this is the area of its basin. Owing to the Andes and Rocky mountains being set back so close to the Pacific, all the large rivers of South America and the greater part of those of North America run eastward into the Atlantic, which thus gets the lion's share of the supply. In fact it takes the water of six-sevenths of the whole of America. From Europe, chiefly through the Baltic and Mediterranean, it has the water of every river except the Volga, and the Mediterranean enables it to get the Nile from Africa, in addition to the Niger, the Gambia, and other large rivers outside on the coast. The amount of land drained by all these rivers on both sides of the Atlantic is estimated at 19 millions of square miles, 2¼ times as much as supplies the Pacific, though the Pacific itself is much larger than the Atlantic. And when we recollect the countless myriads of people who exist on a large part of these 19 millions of square miles—the leading nations of the world, whose welfare and occupations are all more or less closely connected with the great Atlantic and dependent on it, whose lives are bound up with the freight of its vessels and the letters of its mails—we shall begin to realise how mighty a part a great ocean may play in the world, and how "rivers" and "drainage" and "coast-lines" and "basins" can make one ocean more important than another.

96. The **Pacific** differs from the Atlantic in almost every respect, except that it is an ocean. It differs in shape, in area, in extent of basin, in the number and character of its islands. In shape it is a vast field of waters. Instead of the free open look of the Atlantic, the highway of the world, we find an enormous bay, closed at the top, except by the narrow inlet of Behring's Strait, and barred across a large portion of its width by a confused crowd of islands. Its coasts are formed by the long mountain-line of America on the east, and the archipelago of Australasia and Japan on the west. From North to South—the Aleutian islands to Cape Horn—it is 7,000 miles; while its width at the Equator is of the enormous length of more than 10,000. Its area is estimated at more than 67 millions of square miles—more than that of all the dry land of the earth put together. And yet, though its area is so large, its basin is computed at not half that of the Atlantic. On the American coast few important rivers feed it, and the basin is hemmed in by the Rocky mountains and Andes. On the Asiatic side it is more fortunate, as it receives the Amoor, and the great rivers of China, Cambodia, and Malacca. It is surrounded by volcanoes—those of America on the east, of the Sunda and Philippines on the west, the Kuriles and Aleutian islands on the north, and of the Sandwich, Marquesas, and Society islands in its bosom. Of the 250 active volcanoes enumerated by Humboldt, 226 are in and around this ocean. Another remarkable feature consists in its coral islands and reefs, of which there are vast numbers of all sizes, extending over more than 100 degrees of longitude and rising from enormous depths.

97. Third in the list is the **Indian Ocean,**

separated from the Pacific by Australia and the Asiatic Archipelago, and from the Atlantic by Africa, and smaller than either of the preceding. It is truly a double bay of very large size, which forces its way up into the land by the two lesser bays of Arabia and Bengal, and still further by the long narrow inlets of the Red Sea and the Persian Gulf. The Indian Ocean is estimated to cover 29 millions of miles. Its basin is very important, being nothing less than the whole of India and Burmah, including, among many others, the four great rivers, Indus, Ganges, Brahmapootra, and Irawady, which alone discharge the waters of a million and a quarter of square miles into it, as well as the Tigris and Euphrates from Armenia, and the Zambesi from Africa. This ocean also contains coral reefs and islands, though not nearly so many as the Pacific does. Its most striking feature lies in its periodical winds, called monsoons, which take the place of the trade-winds of the Atlantic and Pacific, are vital to the navigation, and have a great effect on the climate of India. It is also much exposed to tornadoes or sudden tempests of the most furious and destructive kind, as at Midnapore, in 1874, when 3,000 people died from the buffeting of the wind alone; and to cyclone waves like that of October 31st, 1876, at Backergunge, when 215,000 persons perished in an hour.

98. North and south of the three main oceans lie the Arctic and Antarctic portions or seas. Of the two the **Arctic** is the best known, partly because it is nearer home, partly because it is more accessible. Here, as often elsewhere, commerce led the way. North-Polar exploration began from the early endeavour to find a "North-west Passage" for the

Indian trade. Greenland, Nova Zembla, Spitzbergen, and the north coasts of Siberia and of North America, which surround the North Pole, have been to a great extent explored and mapped as far north as latitude 83° 20′ 27″. There are even inhabitants up to 81°; the summer, though short, is warm, and vegetation and animals feeding on it have been found as far as 83°. The Arctic Expedition of 1875 killed musk-oxen, hares, and ptarmigan, in latitude 82°. The icebergs, which during the warmer months move down from Baffin's Bay, cling to the coast of Labrador and Newfoundland, and are rarely seen in the open ocean south of Halifax (lat. 44° 39′), or farther east than 40° W. longitude, and there are fast melting away from the influence of the Gulf Stream. Whereas in the south the icebergs advance across the whole ocean as far as 45° and even 40° S. latitude, and make navigation very hazardous beyond that line. They even drift as far as the Cape of Good Hope, a latitude equivalent to that of Gibraltar. In Chili glaciers come down to the sea at a latitude equal to that of Venice. On the few islands found in the Antarctic Sea, the vegetation is of the lowest forms, and the only animal life, birds and seals. The Antarctic continent surrounding the South Pole, has been estimated at twice the size of Europe. Portions of it have been seen at Victoria Land, with its two great volcanoes, Erebus and Terror—and at Graham and Enderby Land; but the great bulk of it is hidden behind an impenetrable wall of permanent ice. Even in summer the temperature of the air is never above the freezing-point, and the snow there never thaws.

99. One main reason of this difference between the Arctic and Antarctic Seas lies in the **currents**

which exist in the ocean, and the greater **circulation of warm water** in the former of the two. It is hardly necessary to say that the sea is never still; but many may not be aware that the waves do not always move forward when they seem to do so, and that unless a *current* is running in the water, the waves only move up and down, and not forward, when the sea is agitated. But there are **currents** in the sea, running through it with definite breadth, just as if they were rivers; and there are the Tides, which are an essential part of the ocean; and there are also **winds** which blow constantly, or for certain seasons, in steady directions over it; and these must all be understood if we wish to know about the sea.

100. Of the **winds,** the chief are the **trade-winds** and the **monsoons**. The trade-winds are perennial, that is they blow during the entire year in one general direction, a regular steady wind from east to west. This they do in the Atlantic and the Pacific, from one year's end to another, in a width or belt of about 30 degrees on each side of the Equator. These winds are great helps to navigation, but before the invention of steamers they were all-important, and in fact got their name from the assistance they gave to trade. Every ship which sailed from Europe to the West Indies, the Brazils, India, or Peru, had to pass through "the Trades;" and during some 50 or 60 degrees of latitude was likely there to find a pretty steady wind to help it on its course. And the same for those who sailed between the West Coast of America and China or India. The trade-winds have left their mark on the map of the West Indies in the names of the "Windward islands" and "Leeward

islands;" the former being those from Trinidad to Martinique, which directly meet the wind, and the latter those from Dominica to Porto Rico, which slope away from it.

101. In the Indian Ocean also the wind blows from east to west from November to March; but from April to October, owing perhaps to the heat accumulated on the mainland during the solstice, it turns round and blows from the south-west, and in so doing brings the rain on the coast of India. This is called in India **the monsoon**, and such an alternating or changing wind is called periodical.

102. Connected with the winds are the **ocean currents**, which, though partly springing from other causes, are much influenced by their constant blowing. There are few parts of the ocean in which a current is not to be found running as fast as 10 miles a day, and sometimes much faster. The chief are the **equatorial currents**, which flow round the globe, or wherever the land will let them flow, in the same direction as the trade-winds—enormous rivers coursing through the ocean. In the Atlantic one of these great streams starts from St. Thomas on the coast of Africa, and runs westward towards the shoulder of South America. Before arriving there it throws off a branch to the south, which goes along down the coast of Brazil to the southern end of South America, and there turns to the eastward towards the Cape of Good Hope. But this is not a very important current.

103. The main stream is very much larger and more important; indeed to us it is nearly the most important thing in the world. It runs nearly due west, about 5 degrees or 350 miles wide, and at a pace of

from 20 to 50 miles a day. It sweeps past the north coast of South America with such strength that not even the immense streams rushing out of the Amazons and Orinoco rivers are enough to turn it aside; passes through the Windward islands, across the Caribbean Sea, and into the Gulf of Mexico, an enormous ocean lake with only two outlets, hemmed in by mountains, and exposed to the full heat of the tropical sun. As the current sweeps round the Gulf it becomes very hot, and is swollen by the waters of the Mississippi, till at length it forces its way out into the Atlantic between Florida and Cuba in a stream of from 30 to 40 miles wide and 600 or 700 feet deep, and at a pace of about 80 miles a day. The Thames at London Bridge is barely 900 feet wide, and the sea from Dover to Calais is 21 miles. These two dimensions will help you to understand what an immense body of water the Gulf Stream is. Its heat when it leaves the Gulf is from 75° to 85° Fahr. At first it keeps pretty close to the coast of America, but by degrees widens out and bears away to the east, running between Newfoundland and the Azores. There it parts; the main body turns round the Azores and goes off southward between those islands and Spain, down to the African coast. The other portion runs on northward between Great Britain and Iceland, bestowing warmth and moisture on Cornwall, Ireland, the Hebrides, and the Shetland islands, as it goes, and throwing forward a stream which bears the weeds and seeds of the New World as far as the coast of Norway and even Spitzbergen, and perhaps even the North Pole.

104. This is the famous **Gulf Stream,** which is poured out of the Gulf of Mexico as out of a vast tank of hot water, to cherish and fertilise the shores of

European and even Arctic countries, thousands of miles distant from its source. This it is which makes the astonishing difference in climate between our shores and those of North America in the same latitudes; which enables myrtles, oleanders, and oranges to flourish in the open air on the coast of Cornwall, while Newfoundland in the same latitude is shut in with icebergs; gives us a beautiful verdant country like the Western Highlands in place of the iron-bound coast of Labrador; and causes the extraordinary fact that no polar ice has ever been known to visit the North Cape of Norway, in latitude 72°, the same latitude with Disco island, on the west coast of Greenland, which may be called the home of icebergs. But the northward motion of the Gulf Stream necessitates a southward motion from the Polar Seas. Immediately beneath the Gulf Stream, and on the inner or land side of it, runs a current of cold water from past Labrador, to replace the warm water brought up from the tropics; and below that again is found a still colder stratum, which has probably travelled up the bed of the Atlantic from the Southern Pole. Such and so constant is the motion and interchange throughout the water of the sea.

105. In the Pacific also there is a great equatorial current which starts from the Bay of Panama and runs right across the ocean, past the Caroline and Ladrone islands to the Philippines. There it is met by a current which issues from the China Sea much as the Gulf Stream does from the Gulf of Mexico, and the two then run outside of Japan, and round the northern limits of the Pacific, and so down again to California.

106. In the Indian Ocean the main current starts from the Bay of Bengal, sweeps past Ceylon and the

Seychelles islands, and between Africa and Madagascar to the Cape of Good Hope. There it is suddenly checked, partly by the Agulhas bank and partly by the sudden cold of the Southern Ocean, and turned back to the south-west towards Kerguelen island.

107. There are many other currents besides those named, but these are the chief, and will give an idea of the ceaseless change going on in the ocean. For wherever water is moved away, other water must naturally come in to take its place.—And thus what I said before is true, that every particle of water probably visits in turn every part of the world.

108. The sea is however stirred to its lowest depths twice every day by a movement of a different kind to those just spoken of. The currents are the earth's own action. They are caused by the natural tendency of warm and cold water to change places, helped by the rotation of the earth, and by the force of winds blowing constantly one way on the surface. But the **tides** come entirely from outside—the earth herself has nothing to do with them, any more than she has with her spinning round the sun; and they move the ocean to its deepest recesses.

109. They are the rise formed in the water of the sea by the attraction of the sun and moon, principally of the moon. The moon attracts all things on the earth, pulls them towards it; and water being fluid changes its shape as it is pulled, and rises up towards the moon in a large heap or wen. But as the earth is spinning round all the time, the water is carried on and will not rise quite in the same shape that it would if it were at rest, but gets spread out into a broad flat wave. This tidal-wave goes travelling along over the surface of the sea, following the moon, and

always two or three hours behind it; and as it comes to the various places along the coast it forms **high tide** there. The moon raises a similar heap of water on the opposite side of the world at the same time; so that there are always two tidal-waves going round at once, each half a day apart. The sun also attracts the water, though, from being so far off, much less than the moon does. When the two come in a line and pull together—that is at full moon and new moon—the tide is highest, and is called **spring tide**: when they are at right angles to one another —that is at the moon's quarters—the tide is lowest, and is **neap tide.**

110. This is the general principle of the tides, but it is very much interfered with by the form of the coast, the depth of the sea, the friction of the water on itself and on the shore, the action of wind, the ocean currents, and many other things. The original height of the tide-wave—the heap of water raised by the moon—is from 3 to 4 feet, and that is the rise of the tide in the open ocean of the Pacific; but where there is a bay or inlet with high steep walls the water will force its way in, and rise much higher. In the Bristol Channel, which is like a funnel with its mouth turned outwards to the ocean, the tides are forced up as high as 30, and, at Chepstow, 50 feet; and in the Bay of Fundy, in Nova Scotia, to 70, 80, and even 100. On the coast of Jutland, in the German Ocean, owing to the tide-wave from the north meeting that from the south, round Great Britain, there is little or no variation, but perpetual high water. You will find all this explained at length in the *Elementary Lessons in Astronomy* (§§659–667). I have mentioned it because

no account of the ocean can be complete without some description of the tides.

111. The surface of the ocean has been pretty well known for a long time, but the inside of it—its depths, the shape and nature of the bottom, the heat at various depths, how the deep currents run, and where the various layers of warm and cold water come from and go to—these have only been begun to be found out quite lately. The Americans took the lead. Captain Maury, of the U.S. navy, was the first investigator, and was followed by the U.S. surveying and sounding expedition of the *Tuscarora* (1873–76). The Germans sent out the *Gazelle* in 1875. Among our own expeditions were those of the *Bulldog*, *Porcupine*, and *Lightning*, from 1860 to 1870, and lastly that of the *Challenger* man-of-war (1874–76), of which Sir George Nares was commander (till he was sent to the North Pole in 1875), and Sir Wyville Thomson chief of the scientific department. In the Atlantic, soundings enough have been taken to enable a general rough map of the bottom to be made, of which I have attempted to give you a view, as if the water were all away, and the dry bed could be seen.

112. It shews the **bed of the ocean** from the Cape of Good Hope to Iceland to consist of a ridge running pretty nearly midway between America, Europe, and Africa, and following in a general way the winding of those continents. This ridge rises to within 8,500 or 10,000 feet of the waves. On each side of it, west and east, there is a valley, which sinks in some places as far as 19,000, 21,000, and even 23,000 feet below the waves. Of the two valleys, the eastern one passes east of the Azores, and round the outside of Ireland. Off Newfoundland the western valley parts :

Fig. 18.

one fork leads into Davis's Strait, the other runs on to Iceland. The three deepest spots known are south-east of Bermuda, off Porto Rico, and midway between South America and South Africa. South of S. lat. 30 the depths are comparatively moderate, not greater than 16,000 and 17,000 feet, and rarely as great.

113. Although the general level of the ridge is 8,000 or 10,000 feet below the waves, yet here and there it rises far above them. The Azores, Ascension, and St. Helena, are peaks of this ridge, and tower above the adjoining valleys to a height of more than 20,000 feet. The Cape de Verde islands, the Canaries, and Madeira stand on plateaus of their own, outliers of Africa. Bermuda is also off the ridge, and curiously isolated, being a mountain of 15,000 feet high, with a base over 100 miles wide, standing on ground which seems to fall away on each side, and to have no other high land in sight, nearer than the American coast, 600 miles off.

114. To get some idea of the general nature of the ocean bed let us take the lowest levels of the valleys just named as a starting-point—equivalent to the "level of the sea" from which the heights of mountains on dry land are calculated. We shall find that the Peak of Teneriffe, which rises 12,180 feet above the ocean, if the sea were dry would really stand up 34,900 feet above the bottom; while in the Azores and Cape de Verde islands there are several peaks that would soar to 28,000 and 30,000 feet above the ocean bed. None of these would seem to have any sudden rise, indeed their slopes appear to be gentler than those of the European mountains.

115. We may further obtain a comparative idea of the height of the submarine mountains of the Atlantic

by supposing that Europe and Asia were covered by the ocean to a depth of 23,000 feet above the lowest ground, that being the greatest depth yet obtained by sounding. In this case not a vestige of land would be seen in Europe. The summit of Mont Blanc would be buried 5,000 feet below the surface, and the highest of the Pyrenees more than 11,000. Ararat would be nowhere; and the first land which would meet the view would be the group of islets formed by 16 or 18 of the highest mountains in the Himalayas and Tibet as they rose above the waves, some just emerging and others reaching a height of about 7,000 feet.

116. The Pacific has been less extensively sounded than the Atlantic, but some extraordinary depths have been discovered there — one south of the Ladrone islands, of 27,450 feet; another off the Kurile islands, of 27,930 feet; and a third outside the centre island of Japan, where 27,858 feet of line was let out without finding bottom. Fusi-yama in Japan is 14,177 feet above the water, so that the total height of its snowy cap from the bed of the sea must be at least 42,100 feet, or 8 miles; that is, 2¼ miles higher than the highest of the Himalayas above the ocean level.

117. On the **heat of the ocean** a great deal has been revealed by the *Challenger's* expedition, and the general result, exclusive of such special features as the Gulf Stream, may be summed up as follows. In all three oceans, within the Torrid and Temperate Zones, the bottom of the sea is covered, as a rule, with a stratum 2,000 to 3,000 feet thick of cold water, varying from freezing-point to 3 degrees above it (32° to 35° Fahr.). In the Pacific this stratum lies at about 9,000 feet below the surface, and there is a line, at 2,500 or

3,000 feet from the surface, below which the water is almost uniformly 40°. Both in the Pacific and Indian Oceans it appears to be proved that this cold bottom stratum comes from the Antarctic Pole. And even in the Atlantic, so much more open to the north than either of the others, the Antarctic water forces its way along the ground beyond the Equator. North of the Equator the bed of the central Atlantic becomes slightly warmer, but it is not till the north of Scotland is passed that the bottom cold stratum appears to be supplied from the North Pole. The heat of the surface varies with the latitude and the time of year. In the enclosed sea of the Indian Archipelago, in January, February, and March, 1875, it varied from 75° to 84° Fahr., with an average of 81·7°.

118. In the Temperate and Torrid Zones at the depth of 12 or 14,000 feet the bottom appears to be generally covered with mud consisting of the shells or skeletons of very small creatures (*globigerina*), similar to those by which the chalk of our cliffs and downs has been formed. In the deeper valleys the bottom is a red clay with no remains of organisms. In the Polar regions the mud of the bottom appears to be pure flint.

119. Now this immense addition to our scientific knowledge, to what is it due? To Commerce. It is Commerce which has called in Science and given it this splendid opportunity of enriching itself. For the depths of the ocean would never have been sounded as they have been, and so many valuable and pregnant facts extracted from them, if it had not been necessary for business purposes to find the best line across the bottom for the Atlantic electric cable. So let no one depreciate commerce, or call it ignoble or sordid!

120. The water in the sea is salt throughout. It is rather heavier than fresh water, its specific gravity being 1·026; that is to say, a gallon of sea water instead of weighing 10 lb. as a gallon of fresh water does, would weigh 10·26 or a trifle over 10¼ lb. In the Baltic, where so many rivers flow in, and about the Equator where there is so much rain, it is much less salt, and therefore lighter. In the Mediterranean, on the other hand, where a great deal of evaporation goes on, and the sea is enclosed, it becomes salter and heavier. The rivers and streams are always at work wearing down the land, and carrying the fragments of its mountains and continents into the sea; and the sea in like manner is always employed in washing over and over the materials thus brought into it. And as this has been going on for millions of years, the sea water must contain all the substances which once formed those materials and can be dissolved in cold water—in other words, every soluble substance in nature. This is why the sea is salt. The chief ingredient in it is common salt, and salts of magnesia and lime are also plentiful. A very small trace of silver is also found, and it gives a startling idea of the vastness of the ocean to know that this minute, hardly perceptible quantity, if it could be all collected, would yield two million tons of that metal, equal in value to £13,440,000,000, seventeen times the National Debt.

FEATURES OF THE EARTH.

121. I have now done my best to give you a general idea of the shape, situation, and character of the dry land of the earth, and of the most striking peculiarities of the ocean. We will end by going through what may be called the principal features of

the face of the earth, its mountains and rivers, capes, isthmuses, promontories, and other portions of its surface, and seeing what hints we can gain from such an examination of them.

122. A **continent** is the mainland of the world, as distinguished from islands which though large are still evidently surrounded by the sea. Australia, though an island, is so much larger than other islands, that it too is called a continent. Indeed, it is within one seventh part as large as Europe itself.—Living as we do in an island, we often speak of the mainland of Europe as "the continent," and of "continental trade," "continental customs," a "continental tour," &c.

123. Strictly speaking the whole of the Old World is one continent. Africa is cut off from Asia by the Red Sea and the Suez Canal, though the interval is a very narrow one, but the division between Europe and Asia is purely artificial. Nevertheless, the distinction between the continents has been so long recognised, and is grounded on so real a difference in the nature of the three, that Europe, Asia, Africa, and America will probably be called the **four quarters of the globe** as long as the world lasts. (§86.)

124. The word **continental** is sometimes applied to the drainage of the high central district of Asia, and other regions in America which are shut out from the ocean, and "contain" their own drainage, the rivers running not into the sea but into inland lakes. (§ 74.)

125. **Island,** land surrounded by water—set in the water, as the eye is set in the face. The word is not from isle, but from **ey*, as in Anglesey, Selsey,

* *Ey* = island. The spelling *ea*, as in Anglesea, Chelsea, Portsea, is wrong.

Orkney; or *oe*, as in Faroe; and we still use it in **eyot** or **ait** for the island near Chiswick and other islands in the Thames. The world has been sometimes said to consist of two large islands, Europe, Asia, and Africa in one, and America in the other, as each is completely surrounded by water; but these large masses of land are always called continents. So is Australia. The largest island is Borneo, and the next New Guinea. Great Britain ranks seventh in the scale. One of the smallest inhabited ones is perhaps Heligoland, which, though but a third of the size of Hyde Park, and boasting only a single tree, contains 2,800 inhabitants.

126. Islands are the tops of mountains rising from the bottom of the sea, in many cases very high mountains. Bermuda rises from a depth of 15,000 feet, with no other known eminence on either side nearer than 600 miles, much as if Mont Blanc were planted quite alone in the middle of Russia. The Antilles, or small islands of the West Indies, rise from ground which in many places is from 15,000 to 20,000 feet below the water, and as they stand from 3,000 to 6,000 feet above it must represent a truly magnificent chain of mountains. The Azores are a group of from 10,000 to 16,000 feet high, standing upon a plateau of about 700 miles in diameter, itself rising to a height of more than 6,000 feet above the general level of the ocean bed. This would make the height of the Pico (which is 7,613 feet above the ocean) fully 22,000 feet in all above the great valley of the Atlantic bed, and the others in proportion.

127. The Canaries would form a splendid outpost to Africa. If the sea were to retire, the three islands of Teneriffe, Palma, and the Gran Canaria would appear

as peaks towering to the heights of 23,000, 19,000, and 18,000 feet above their bases. In the Pacific the Ladrone islands appear to rise suddenly to a height above the ocean bed of between 27 and 28,000 feet; while Japan and the Kurile islands to the N.E. of it must be even yet more lofty.

128. The great islands of Borneo, New Guinea, and others which lie between Australia and Asia were probably at one time a continuous continent, lying to the south of Asia, much as South America does with respect to North America.

129. The **coral islands,** with few exceptions, are only to be found between latitudes 30° N. and 30° S. of the Equator, and oftenest in the Pacific Ocean; they appear to be formed on the tops of submarine eminences, which are gradually sinking with the bed of the sea. This opinion (Mr. Darwin's) is grounded on the fact that the creatures which make the coral can only work between the surface and a certain depth (90 to 150 feet); and as the coral goes down much beyond that depth, it is inferred that the islands have been gradually sinking so as to allow the animals to keep adding to the top, as they are still doing. The coral usually forms a round ring from one to thirty miles diameter, and a quarter of a mile or so in width, enclosing a lagoon of water with one doorway to the ocean, on the leeward side. On the ring earth gradually collects, and palm-trees grow. Outside, all is noise and fury, the waves of the ocean breaking on the coral in tremendous surf; inside, the water is perfectly still and clear. These islands are called "atolls."

130. When coral comes near the surface, but not

above, it is called a **reef.** The largest of these is the Great Barrier reef, off Queensland, on the N.E. coast of Australia, a natural breakwater 1,000 miles long, which protects the coast from a terrible sea, and leaves a calm still channel for ships within it.

131. **Archipelago** is a word used for a collection of islands, at first for those in the Ægean Sea, between Greece and Asia Minor, and afterwards for various other groups, such as the Malay Archipelago, Borneo, Java, Sumatra, and the rest; the Low or Dangerous Archipelago in the South Pacific, and the Chagos Archipelago in the Indian Ocean. In the two last cases the groups consist partly of reefs and half-formed islands.

132. **Cape**—that is, head—a part of the coast running out into the sea, usually a bold headland, the end of a mountain, sometimes called a promontory. Such, though not called capes, are Beachy Head, Flamborough Head, and St. David's Head; and such, but much larger, is the Cape of Good Hope, which is the end of the high plateau of South Africa. Other famous capes are Cape Farewell, at the south point of Greenland; North Cape (an island), the extreme north of Europe; Cape de Verde, the west cape of Africa; St. Vincent, on the coast of Portugal; Finisterre, and Trafalgar, on that of Spain. Cape Horn, the southern extremity of South America, is an island, one of the group off the mainland which forms the Tierra del Fuego.

133. Where the point of land is low, it is often called **ness**—that is, a nose; as Dungeness, which contrasts well with Beachy Head; and on the low coasts of Kent, Essex, and Suffolk we find Sheerness,

Shoeburyness, Foulness, and Orfordness, and even The Naze. The name came from the Danes or the Northmen. It is found on the coast of Norway, and on that of Scotland, which they frequented, as *naes* or *noss*; also at Grisnez, opposite Dungeness. On the south coast of England the word **bill** is similarly used, as Selsey Bill, Portland Bill. Other words used for headlands in Scotland are **mull** and **butt.**

134. **Mountains** are the largest eminences of a country, and **hills** the smaller ones—as we say the "Welsh mountains," and the "Surrey hills." But this distinction is not always kept up. The "Mount of Olives" is a moderate-sized hill, and the "Neilgherry Hills" are mountains more than 8,000 feet high. In India, again, the "Hill States" are territories high up in the northern mountains, and "going to the hills" means migrating for the hot season to Simla or Murree, which lie thousands of feet up on the spurs of the Himalayas. Sometimes, too, a collection of mountains is called a "mount," as Mount Lebanon, which is really a range 50 miles long and, in some places, 12,000 feet high.

135. Mountains may be single and independent, like Etna or Vesuvius, and then they are generally volcanoes. Or they may be connected in one long range, or chain, or *cordillera*, like the Pyrenees, or the Apennines, and the Caucasus; or in a double chain of two parallel main ridges, or even more, each perhaps a hundred miles apart, with great valleys and table-lands and smaller mountains between them, like the Northern Andes and the Rocky mountains, between the ranges of which lie great countries like Mexico, and Peru, and Oregon; or

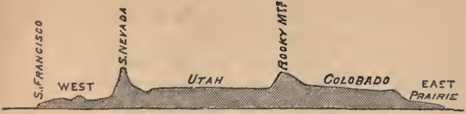

Fig. 19.

like the Himalayas and Kuen-luns, which are 600 miles from each other, and have between them the whole region of Tibet. Or they may be collected

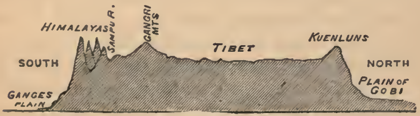

Fig. 20.

together with no very obvious arrangement; like the Alps, which include the groups of the Oberland, Mont Blanc, Monte Rosa, the Grisons, and the Tyrol.

136. The highest mountains in the world are the Himalayas, where there are four peaks rising to 29,002, 28,265, 28,156, and 26,826 feet, and many others nearly as high. In the Andes there are seven mountains which vary from 25,250 to 15,931 feet. Mont Blanc is 15,784; Ben Nevis, 4,406; Snowdon, 3,590 feet. It must be remembered that these heights are all measured above the sea; whereas the mountains are often planted inland, on considerably higher ground; for instance, the height of the valley of Chamouni, at the foot of Mont Blanc, is 3,500 feet, which thus takes nearly three-quarters of a mile off the nominal height of the mountain. But, as we said

before, even at the best how small are such heights when compared with the earth's diameter. They are no more than the heads of the nails which fasten the lead to the dome of St. Paul's; and if you were on the moon looking at the earth, they would make no difference whatever in the roundness of the globe.

137. The appearance of a mountain is often deceptive. The height and slope appear greater than they are; the rise of the mountain is full in view, and your own height gives you a vertical measure of it, whereas you have no means of estimating the distance of the slope from you, or the rate at which it slants away, and is lost in the distance. Few mountains rise at a steeper angle than 45°, and most are much less. The Peak of Teneriffe, which, from the harbour, seems to be almost over your head, is said to slope only at an angle of 12° 30′. (§ 67.) You read in books of "vertical heights," and of mountains "overhanging" a town or a valley. These words may convey the appearance of the spot correctly, and the effect on the mind of the writer; but they are quite inaccurate as to fact. The mountains round Innspruck, when viewed from the town itself, seem almost to overhang the streets, and enclose it like the sides of a deep cup; but they are really many miles distant, and their slope is but gradual.

138. The **crest** or **ridge** of a mountain is the general line of its range, above which the principal peaks project. Thus the general or mean height of the Pyrenees is about 8,000 feet, though some of its summits rise to more than 11,000. *Sierra*—a saw—is a word which the Spaniards apply to a range of mountains, such as the Sierra Nevada, the Sierra Sagra, &c., in Spain, Mexico, and South America.

139. **Passes** are notches in the crest of a mountain by which it is easiest to cross from one side to the other; the roads of the Stelvio, Simplon, and Splugen, by which we cross the Alps between Switzerland and Italy, are examples. Other passes are too precipitous for carriage or horse, and must be crossed on foot; such are the S. Theodule, Col de Géant, &c. The Khyber and Bolan passes, between Hindostan and Afghanistan, were the scenes of some of the great disasters of our army in 1841–42. Some of the passes in the Himalayas by which the merchants go from India to Kashgar, Ladak, or Tibet, are as much as 18,000 feet high above the sea; that is they have to climb that height, before they can find a gap allowing them to cross from the south to the north side of the mountains.

140. The heat of the air becomes less as we ascend a mountain, and at last it grows so cold that the snow remains there always. The height at which this takes place varies with the part of the earth we are in, and with other things; as, for instance, whether the mountain faces south or north, whether it is steep or not, whether it is exposed to cold winds or warm winds. In the Andes, between the tropics, the **snow-line** varies from 15,000 to 20,000 feet above the sea, according to circumstances. On the Himalayas it is 15,500 feet on the south side and 16,600 on the north side; on Mont Blanc it is 8,500 feet. Warm winds contain a great deal of moisture, and when such a wind blows on to a cold mountain it drops its moisture; in other words rain falls. And this is the reason why there is so much rain in mountainous districts. The heaviest annual rainfall in the world is in the Khasia hills, behind the Bay of Bengal,

where the hot damp winds from the Indian Ocean meet a cooler atmosphere, and drop not less than 50 feet deep of water in the twelve months. In the Cumberland mountains the rainfall is from 15 to 18 feet annually, while away from the mountains on the same coast it is only from 2 feet 6 inches to 4 feet. Sometimes mountains intercept the whole of the rain, as the Andes do. An immense quantity falls on their eastern or Atlantic side, while on the coast between the Andes and the Pacific it is very seldom seen. In the district between the Rocky mountains and the Cascade mountains, the former intercept the rain from the Atlantic, and the latter that from the Pacific, and the land receives none.

141. By thus intercepting the moisture of the air mountains cause great differences in the climate of places on opposite sides of them. Thus with the Dovrefeld, the great mountain range of Norway, on the west or seaward side the difference between the temperatures of summer and winter is only 18°, while on the other side of the range, by the Gulf of Bothnia, the difference is 42°; the summer being much hotter, the winter much colder.

142. If the mountains are not covered with perpetual snow, the rain that falls and does not sink into the ground runs off in torrents and streams and waterfalls. If they are colder it falls as snow, and then forms **glaciers**, which may be described as rivers of ice, filling the upper valleys many hundred feet deep, and slowly forcing their way down into the lower parts. As they get lower, into the warmer air, the glaciers melt, and from the lower end—sometimes called the "toe"—a river will flow away, as the Arve does from the lower end of the Mer de

Glace, or the Rhone from the glacier below the Furca. Thus glaciers so far perform the same office as lakes (§ 192); they receive the sudden masses of snow, store them up, and release them gradually in the form of streams, always flowing to refresh and fertilise the valleys below, and to delight the eye by the continual contrast of the verdure beneath with the rocks and snow above.

143. We in Europe can form little idea of what a frightful calamity the want of mountains and streams is. Australia will probably suffer from it to the end of time. Had that great continent been divided by a range of mountains, sufficiently lofty to have had perpetual snow, and thus to intercept the hot winds and rob them of their moisture, it would have been one of the richest countries in the world; and its interior, instead of being, as much of it is, a wilderness of countless sand ridges, itself devoured by scorching winds, and the source of drought and oppression to the settlements on the coast, would have been one giant field of corn and pasture.

144. But from whatever source it started, the river carries away sand and stones, which the rain or the glacier have soaked or scraped off the mountain; and thus the circle of nature goes on. The mountain causes the clouds to drop their rain: the rain wears away the mountain and hurries down its sides, gradually raising the lowlands with what it brings down, and carrying the remainder into the ocean, from whence, while the sand goes into the depths to form new rocks, the water rises again in vapour, to repeat, over and over again, the same process of destruction and supply.

145. Mountains have played a great part in the history of many countries by affording a refuge for the

people when the lowlands were conquered, and preserving for long the names, manners, and customs of the first inhabitants of the country. The Peak of Derbyshire, and the Cumberland mountains, contain more names in the Celtic or old British dialect than the lowland districts round them do; Wales and the Highlands of Scotland are still inhabited by the old British peoples whom the English could not drive out as they did those of the flatter parts of Britain. In Switzerland, the Caucasus, and Southern India, the mountains are still the abode of the primeval races—and the same elsewhere. There, far away from cities and communication with the rest of the world, they preserve the simple virtues of primeval life, though they also preserve its ignorance and prejudice. In Kaferistan, a very inaccessible mountain-region of Central Asia, on the southern slopes of the Hindoo Koosh, all attempts at intercourse with the ancient people have been unsuccessful, so that, though a large and prosperous nation, their numbers, language, and creed remain to this day unknown.

146. This has occasionally been reversed, as in the conquest of Palestine, where the Jews took possession of the heights, and left the plains to the Canaanites; and in some parts of Italy to the present day the villages adhere to the mountain side, and for the same reason, namely, that the plains were the resort of robbers and plunderers, from whom safety was only to be found in the hills. Both cases shew the influence which mountains have had on the life of the nations who dwell among them.

147. Nor should we forget the protection which a chain of mountains affords to those who dwell behind them. But for the Alps, Italy would no doubt have been

overrun by the northern barbarians centuries sooner than it was; Napoleon could not have invaded it but for the road across the Great St. Bernard, and the fact of his making the Simplon road afterwards, at an immense cost, proves how great an obstacle he felt the mountains to be to his movements. Thus mountains, and not rivers, are the usual boundaries of different countries. The Cheviots form more than two-thirds of the barrier between England and Scotland. The Franco-German war of 1870 showed that the Vosges mountains, and not the Rhine, were the real division between France and Germany. The Pyrenees and Alps are obvious instances of the same thing.

148. In many cases mountains take their **names** from the snow on their tops. Himalaya is the "abode of snow;" Dwajalagiri is "the white mountain;" Lebanon the same; Apennines means "the white head;" Caucasus is "white with snow." Mont Blanc, the Sierra Nevada, the Weisshorn, the Snäfell in Iceland, the Sneehattan in Norway, are all names derived from the snow. But this is not always the case, even where we should most expect it. Andes means "copper;" Fusi-yama, the snow-capt mountain of Japan, is "the mountain of the rich men;" Pyrenees is "high;" Aghir-dagh (Ararat) is the "huge mountain." Ural is a "belt or girdle;" Alp is probably a height; Hecla, "a cloak," is so called from the smoke which hangs over it; Table mountain from its flat shape; Etna means a furnace in Phœnician, but it is now usually called Mon-gibello—"mountain-mountain," or "the mountain"—by the peasants of Sicily.

149. Other mountains are called after their discoverers or explorers, or other eminent persons,

as the Owen Stanley range in New Guinea; Mount Everest, and Webb's Peaks in the Himalayas; Mount Murchison, and Fremont Peak, in the Rocky mountains. The great volcanoes in South Victoria Land are called Erebus and Terror, after the two ships of Captain James Ross who discovered them. Some great mountains seem destined to be known for ever by a mere surveyor's number. The second loftiest peak in the Himalayas appears in the map as "K 2."

150. In speaking of a mountain it is curious to notice how it is treated as a person. Mont Blanc has been called the "monarch of mountains;" the Jungfrau means the "virgin;" in Cumberland we have "the Old Man," which answers exactly to Jebel-esh-Sheikh, the modern name for Mount Hermon. And not only so, but the names for the different parts of a mountain are mostly taken from the human body, such as the head, crown, shoulder, breast, gorge (*i.e.* throat), side, back, flanks, foot, instep, and heel, and in French *col* (neck), for a pass. We even speak of the "saddle" and the "spurs," and when a line of mountains runs from end to end of an island, as the Blue mountains in Jamaica, they are appropriately named its "backbone."

151. I have mentioned **volcanoes** or **burning mountains**. There is great difference of opinion as to their number. Some say that there are 400 in all, others that there are no less than 900 in the islands of the West Pacific alone. Many of them seem to have altogether ceased to burn, but others are in constant eruption. A volcano is a hole going down below the surface and through the crust of the earth, up which melted lava or red-hot cinders and dust are blown from underneath. The quantity thus thrown out is sometimes almost beyond belief. At Tomboro, a

burning mountain in Sumbawa, in 1815, cinders and dust enough were thrown out to form three mountains equal to Mont Blanc, or to cover the whole of England and Scotland to a depth of 7 feet. In 1783, lava was forced out of a volcano in Iceland, equal to 21 cubic miles. In 1835 there was an eruption in Mexico, the ashes of which covered the ground for more than 20 miles round the mountain to a depth of 10 feet, and were carried as far as Jamaica, fully 1,000 miles off.

152. You can understand that as the stones and dust and ashes are blown out of the hole they will form a heap round about it. This heap is called the cone, and the hole itself goes down like a funnel through the cone and is called the crater. Besides the main crater others break out and vomit forth stones and dust and cinders and lava; and lava will burst out of the side of the mountain and flow like a small river of melting iron, though the surface soon cools and gets thick, and then runs very slowly and forms huge ugly lumps. A field of lava after the lava is cold is one of the most hideous sights in the world. Thus by degrees a mountain is formed round the crater. Etna is nearly 11,000 feet high, and 87 miles round the base, and was probably all formed in the way described. Sometimes, as at Ternate and Tidore, in the Moluccas, which are regular symmetrical cones of from 5 to 6,000 feet high, the volcano appears to have risen to its present height by the outpouring of the single crater.

153. These particulars rather belong to geology than geography, and you will find full information upon them in the *Primer of Physical Geography* (p. 103); but there are some things about volcanoes which must

be noticed here. One is that they are seldom or never far away from water. Etna, Vesuvius, and Hecla are all close to the coast. The volcanoes of the Andes line the eastern shore of the Pacific for several thousand miles; and from North America through the Aleutian and Kurile islands, Japan, the Philippines and Java, to New Zealand, volcanoes may be said almost to enclose that ocean.

154. Another point is that they often occur in straight lines, as if over a crack or weak place in the earth's crust. In the Aleutian islands there are 23, covering 900 miles in length. In Kamschatka and the Kurile islands they extend 540 miles in a line, in the Ladrones 420, and in the Sundas for nearly 1,000. But as each volcanic mountain is, from the way in which it is formed, independent—each collected around its own crater or craters, and formed by the heaping together of the materials thrown out of the crater—volcanoes are, as a rule, different in shape from mountains of upheaval.

155. Old lava broken up and worn down by the action of the weather forms a peculiarly rich soil. On the slopes of Vesuvius grow the grapes from which the famous wine called Lacrima Christi is made. Madeira is a mass of disintegrated volcanic rock, and the plain of Gennesareth, at the N.W. corner of the Lake of Galilee, one of the richest little spots in the world, derives its fertile soil from the wearing down of the basalt of an old volcano just above it.

156. **Valleys** are the natural opposites to mountains. A valley is the trench or hollow through which a river flows—as the valley of the Thames, the valley of the Nile, the valley of the Rhone, the vale of Clwydd; meaning the whole extent between the heights on the

one side of the river and the heights on the other. Thus it expresses something like what is meant by the more exact word basin (§ 200), though the basin takes in all the sources and feeders of the river, up to the very farthest and smallest, whereas the valley relates to the stream alone. The valley must have begun in some accidental hollow in the ground, which attracted the water to flow along it, and which has been gradually deepened and widened by the flow. Though originally formed in this way it is not necessary that the river should still be there; many causes may have altered its course or lessened its flow. Sometimes the bed of the valley will be occupied by a series of lakes.

157. **A plain** is a district of more or less even ground, not broken up by mountains or hills. It may have undulations of its own, and may rise by degrees to a considerable height, but it will do so by long, easy slopes. Thus Salisbury Plain is a succession of hollows and rises, over which the road goes gently up and down. Some plains are alluvial—that is, have been deposited by water—and these are almost absolutely level. Such are parts of the counties of Cambridge, Norfolk, and Lincoln; and such are the plain of Crau, between Arles and Marseilles—which is the older part of the Delta of the Rhone; or the whole of Lower Egypt, which is the Delta of the Nile; or, on a larger scale, the Steppes of South Russia, and the plains of Western or Lower Turkestan, at one time the bed of an ocean of which the Caspian and Aral Seas are traces.

158. When a plain is some height above the sea-level, it is called a **plateau** or **table-land.**

159. The greatest plain in the world is that which

has been already (§72) described as spreading over the northern part of Europe and Asia, from Cambridgeshire to the eastern end of Siberia. On the European side its mean height above the sea-level is about 500 feet, on the Asiatic side rather more. Each portion is distinguished for its rivers; those in Europe drain partly into the Baltic and partly into the Black Sea, and the mighty Volga itself discharges 1-7th of all the water of Europe into the Caspian. The rivers of the Siberian plain are far larger even than the Volga, and they all discharge into the Arctic Ocean; the table-land of Central Asia preventing all drainage to the southward. The **steppes** of Europe are the country about the lower part of the Dnieper, the Don, and the Volga, a level district about 200 feet above the sea. East of the Volga the land falls below the sea-level, and these are the **lower steppes.**

160. The Altai mountains, and their continuation eastward, which shut in Siberia on the south, are the beginning of the mass of high land which ends in the range of the Himalayas. The country rises southwards by successive terraces: first the plateau of Mongolia and the sandy desert of Gobi, forming together a district of from 1,200 to 1,800 miles from west to east, and 600 broad from north to south, and from 2,500 to 3,000 feet in general height. Then come the Kuen-lun mountains, forming the buttresses to another step upwards, to the very lofty plateau of Tibet, 700 miles long by 350 wide, and 15 to 17,000 feet high. This is absolutely shut out from all communication with the ocean, and its rivers, though large, all flow into lakes, with no outlet but that of evaporation. South of Tibet are the

Gangri mountains, dividing it from the valley of the upper Brahmapootra, over which towers the double range of the Himalayas, with a general height of 18,000 feet, and peaks which reach 29,000.

161. The Lowland plains of S. America lie between the Andes and the Atlantic, and form 7-8ths of the whole of the South continent. They are known by the names of the Llanos, or Savannahs, in the north, and the Pampas in the south. The Selvas are a forest district in the basin of the Amazons. These plains are flooded every year by the great rivers which flow through them.

162. The interior of North America, between the Rocky mountains on the west and the Alleghanies on the east, is an immense plain, sloping up very gradually from the Gulf of Mexico to a summit of about 1,500 feet in height. The northern slopes of this summit drain into the Saskatchewan and Red rivers, the southern into the Missouri and Mississippi; and north-east of it is the great chain of fresh-water lakes which discharge through the St. Lawrence into the Atlantic. The northern and eastern portions of the great plain, some 1,400 by 1,000 miles, are the prairies, undulating regions covered with coarse grass.

163. The Sahara, or burning desert of North Africa, is 3,000 miles long from the Atlantic to Egypt, and over 1,000 in width, equal in area to the whole of Australia, and varying in height from below the sea to 1,500 feet above it. The extreme east end of the Sahara is the land of Egypt, where the sand is fertilised by the annual inundation of the Nile.

164. The Dasht-i-kavìr of Northern Persia is a desert of salt swamps which appears to cover a space

of 6 degrees of longitude by 2 of latitude; but it is so little known that I am only able to mention it.

165. **Peninsula**, a country or piece of land not quite an island—not quite surrounded by the sea; such as the Morea or the Crimea, each of which is a perfect example. If South America were smaller, it too would be a perfect peninsula, hanging on as it does from North America by the little shred of Panama (fig. 15); and so would Africa, which is connected to Asia only by the narrow neck of Suez. Indeed, since the Suez Canal was made, Africa is practically an island. But these great lands are continents, and it would be disrespectful to apply the term peninsula to either of them.

166. Where there is a peninsula there ought to be an **isthmus**, which is the neck of land connecting it with the mainland; and the best examples of this are the Isthmus of Darien or Panama; that at Perekop at the head of the Crimea; and the Isthmus of Corinth, which connects the Morea with Greece. This last was "*the* Isthmus" with the Greeks, and gave its name to the Isthmian games, which were played there.

167. The peninsula with which we are all most familiar is that of Spain and Portugal, where the Peninsular war was fought. In fact, in the mouths of many people, "the Peninsula" means these two countries. We also hear the expression the Peninsula of India; but the word is incorrect in both cases, since the part where Spain joins France is more than 200 miles wide, and the broadest part of India is where it joins the continent—that is, where the neck of the isthmus ought to be.

168. With the Greeks a *chersonesus* was the same

thing as a peninsula with us. They called the Morea the Peloponnesus (the island of Pelops), the Crimea the Tauric Chersonese, and the peninsula of Malacca the Golden Chersonese.

169. A **river** is the largest kind of stream, always flowing, never dry. Small streams are **rivulets** or **brooks.** A **torrent** is a stream which flows only in the winter or rainy season, and in summer is dry or much reduced, leaving a wide empty bed of stones and sand, with a small stream in the middle. In Italy this is called *fiumara*, in India *nullah*, in Syria *wady*. In Spain, *wady*, an Arabic word, has become corrupted into *guad*, as in Guad-alquivir, Guad-arama, &c. In North America and Australia the word **creek** is used for a river of secondary size, whether permanent, or dry in summer. But a creek (that is, crack) is correctly an opening in the shore narrower than a gulf. (§ 204.)

170. When you stand by a great, strong rushing **river,** like the Rhine at Basle or the Thames at Battersea Bridge, it is hard to believe that all that mass of water is made up of separate rills and drops, gathered one by one from the land the river passes through. And it is harder still not to imagine that if you wait long enough it must pass away before your eyes, and leave the bed dry. It seems impossible that so much water can go flowing on for long. But in both cases you are wrong. The Rhine and the Thames will live longer than you will, and they are made of contributions from innumerable sources.

171. Rivers are the drains of a country. The water falls from the sky in rain or snow, and will naturally drain off by the lowest levels till it reaches the lowest of all, the sea. As it goes along, one drain

joins another, until at last they all get united into one large main drain, and this we call the river. This is easy to understand where the country consists of mountains and slopes, but the same thing happens where it is so flat that, to the eye, there appears no slope at all; the water will always find out the lowest level, and along that it will travel, unless it be a hole, and then it stays there and forms a lake.

172. A river may have its source—that is, its longest branch may begin—in a spring, like the Jordan; or a lake like the St. Lawrence, the Amazons, and probably the Nile; or a glacier like the Rhone; but it is not the source which makes a river large, it is the number of other rivers and streams which flow into it, and bring down the water of the various basins which they themselves have drained. A river which runs into another is called an **affluent** or **tributary**, and the place at which they join is the **confluence**. A river does not usually grow broader after it is joined by a tributary, but it runs faster, and therefore is able to carry along the extra load of earth and stones which the tributary brings into it. For we must remember that one great office of rivers is to bring down the materials of the highlands to the lowlands and into the sea, and thus continually to renew the face of the earth. The Nile, for instance, every summer spreads a layer of rich mud over the fields of Egypt, which is as good as a coat of manure.

173. A river which gets much of its water from mountains has a small basin, is very rapid in its flow, subject to frequent sudden floods, deep in winter, shallow in summer, boats cannot make way against the stream, and little trade can be carried on upon it. Thus the Rhone, which rises in the heart of

the Alps, is 504 miles long, and has six main tributaries, its basin is 38,000 square miles, it descends through 5,600 feet, it is the most rapid river in Europe, perhaps in the world; the stream is so strong that its navigation can only be carried on by steamboats, and even that only below Lyons. The floods are often terrific, and the number of people and buildings destroyed by them is immense.

174. Now take a river of a different kind. The Mississippi has more than a hundred affluents, of which the Missouri is fully as big as itself, while several of the others are mighty streams. The land drained by the whole of these rivers, which at last collect in the one channel of the Mississippi, is more than a million of square miles, and chiefly flat land. The Missouri gets much of its water from the Rocky mountains, but the Mississippi itself and its other great tributaries drain a country which slopes so gently that at 2,400 miles' distance it is not quite 1,500 feet above the sea. But the current is very strong and muddy, always running down, full of sunken trees and very dangerous to boats, and the trees and timber which it brings down so fill it up as in some places to stop the passage almost entirely. The windings of the Mississippi also are so great as to make some parts of it double the length. The Volga, the largest river of Europe, 2,700 miles long, drains a surface of half a million miles, for the most part so flat that the highest land in all that space is but 1,100 feet above the ocean. The Volga, too, is always running one way; its mouth is barred by sandbanks; and after all its length and its many windings it ends, not in the open sea but in the Caspian, a lake without any outlet.

175. By the side of these giants, the **Thames** is

but a little river, only 210 miles long, with a dozen small affluents; and its whole basin but 6,160 square miles. But on the other hand, partly by nature, and partly by the care of man, its stream is full and even from end to end, with no undue or vexatious meanderings; free from rapids, currents, or sandbanks; its water clear and pure except where we have spoilt it; navigable over nearly the whole of its length; always friendly and serviceable. The frosts which in North America and in many of the rivers of Europe imprison the traffic and hold it dormant during many valuable months, are all but unknown to the Thames. It enters the ocean at a sheltered place, and above all it is a **tidal river.** This keeps its mouth free from bars and shoals. The current though full is so gentle that the tide from the sea can overcome it and force it back, and thus twice a day the tidal water runs up beyond London, and twice a day runs down again, so that ships, barges, and lighters can float up or down without wind or other help. This natural and spontaneous movement is one of the things that have helped to make London the great place for commerce that it is. Every ship or boat that goes from the sea to Paris, Lyons, or Cologne, has, on account of the downward speed of the river, to be dragged there against the force of a constant strong current, instead of being floated up or helped by the natural tide, as it is here. Think of that whenever you see the Thames washing the quays of the Embankment, and the barges floating up or down with no expense but that of the steering oar.

176. The **mouth** of a river is where it ends, and empties itself into the sea or a lake. When the river comes from or through a soft or sandy country it brings

down mud in the water. As long as the water is running fast the mud is carried along; but when it meets the sea and comes to rest at its mouth, the mud falls down and forms a bed or bank between the river and the sea, spreading out in the form of a fan. This is the case where the Nile runs into the Mediterranean.

Fig. 21.

177. The Greeks called the place *delta* after the name of their letter Δ which is so called; and since then all river-mouths of that kind have been called **deltas.** The point of the triangle, where the river originally entered the sea, is called the **head** of the delta. If there is a tide at the mouth of the river it will wash the mud away as fast as it is thrown down, and prevent the delta from forming. And therefore the principal deltas are in seas which have no tide, as at the mouths of the Nile, the Po, and the Ebro in the Mediterranean,

of the Volga in the Caspian, and of the Mississippi in the Gulf of Mexico. This last covers more than 30,000 square miles—very nearly the area of Ireland—and has its head 200 miles up the river. Holland is a large delta of very ancient date formed at the mouths of the Rhine and the Meuse; and Holland and Lower Egypt are good examples of the way in which land is made out of the sea by the agency of a river.

178. It follows from what we have just said that the mouths of tidal rivers—which are called **estuaries**—are, like the Thames, as a rule free from bars or sand-banks.

179. Where the fall of rivers is rapid, and they bring down many stones or much mud in their water, they gradually drop stones and sand as they go along, and so the bed is continually raising itself. You may see this in North Wales, where a mountain torrent will often run on a kind of embankment of stones and rocks, several feet above the fields it runs through. But in Italy such rivers as the Po, the Ticino, and the Dora Baltea have raised themselves many yards above the country; and in consequence, when their waters are swelled by the melting of the snow on the mountains or by much rain, and they overflow their banks, they rush down into the country on each side, and carry everything away. The quantity of sand and sediment brought down by some rivers is enormous. That of the Ganges is computed to be six thousand million cubic feet in the year, which, if it could be heaped up before us, would form a mass equal in size to 600 St. Paul's Cathedrals; and this has been going on for thousands, perhaps millions, of years. Picture to yourself the way in which the earth must be wearing down under such influences.

180. The rivers of Great Britain, even in the wettest seasons, keep to their own beds, but in India so great is the rush of water from the mountains in the rainy season, that it is no uncommon thing for a river to make a new bed for itself in the soft soil of the plains, and to wander several miles away from its old course, to the destruction of everything in its road. The Indus is an old offender in this way.

181. The slope or **fall** is different in different rivers, and in different parts of the same. A river like the Rhine or the Rhone, which rises high up in the mountains, falls very quickly in the upper part of its course and more gently afterwards. As far down as Basle the Rhine falls through a height of 4,000 feet in 230 miles, or 17 feet per mile. Between Basle and Mayence (246 miles) it falls 555 feet, or 2¼ feet per mile. The slope of the Rhone between Geneva and Lyons is 6 feet 9 inches per mile, and from Lyons to the sea 2 feet 8½ inches per mile. The Nile, in the 1,000 miles from Khartoum to Philæ, falls through 784 feet, or about 9 inches per mile. Here the cataracts cease, and for the rest of the distance to the Mediterranean at Damietta, 600 miles, the fall is 354 feet, or 7 inches per mile. The Amazons, during the upper 3,000 miles of its course, falls 10,000 feet, or 3½ feet per mile; during the last 400 miles it suddenly subsides, and slopes only 40 feet, or 1¼ inch in a mile. The Thames, from Chertsey to Teddington, slopes 17½ inches per mile, from Teddington to London Bridge (17½ miles), 9 inches per mile, and from London Bridge to the Nore (46 miles), 1 inch per mile.

182. The **speed** of a river does not usually depend on its slope so much as on its depth, or the body of

water it contains, and on the straightness of its course. If there are many windings and the river is shallow, the speed is much reduced by the friction of the water against the sides and bottom. The average speed of the Nile, Rhine, and Ganges in their lower portions is said to be from three to four miles an hour; the St. Lawrence, below Niagara, about three miles an hour; the Thames, from Battersea downwards, at low tide—when the river is left to itself—from 3 to 3½ miles per hour. We can form some idea of the vast body of water which is poured out by the Mississippi into the Mexican Gulf, when we know that notwithstanding its gentle slope and very crooked course, and the many hindrances of timber, &c., already mentioned, the force of the current is enough to hurl the water out so violently that its mud discolours the sea out of sight of land.

183. A river is rarely the boundary between two nations. The large rivers we have spoken of run through their own countries. The French wished to make the Rhine the boundary between a part of France and Germany, but the Vosges mountains are the actual barrier. In fact a river is rather a ready means of communication than a barrier.

184. You will often see the expression "right bank" or "left bank" of a river. You are supposed to be at the source, looking down the stream. Then the right bank is to your right hand, and the left bank to your left hand.

185. The names of rivers are so curious that it will be well worth our while to bestow a few minutes upon them. They are amongst the oldest names in the world; they pass through the oddest changes as the

language of the country alters, but the old word remains firm and fast at the bottom of the new form.

They are the memorials of the very earliest races, surviving amidst the latest civilisation. As the old British stones at Avebury linger among the cottages of the modern village, so does the Celtic word for water still sound in the name of *Ox*ford. After the North American Indians are extinct their language will survive for ever in the names of the Pótomac and Susquehanna rivers.

The principal river names in England are four. They are Celtic words, of the language spoken in the island before Romans or Englishmen came into it, and still spoken in Wales and the Highlands; and they mean simply "river" or "water."

186. *Avon.*—There are no less than fourteen rivers with this name unchanged in Great Britain, and still more have it in a modified form, as Evan, Inn, &c. *Afon* is the Welsh word for river, and the Welsh speak habitually of the "Afon so-and-so," as we do of the "River so-and-so."

187. *Dwr* (pronounced like poor).—There are three rivers called exactly by this name, and many others called Dore, Duir, Dover, Dura-water, Thur, Adur, and other forms. Joined with the word *gwyn*, clear, *dur-gwyn*, the clear water, it appears as Derwent, of which name there are four rivers in the north of England, besides the Darwen and Derwen, and the Lake of Derwentwater. It is easier to say Darent than Derwent, and so Darent it has become in Kent, and from Darent, Dart, or shortened in another way, Trent. Trent used to be supposed to mean thirty, from the Latin *triginta*, French *trente*; and they said it

was because the river had thirty *tributaries, thirty monasteries on its banks, thirty kinds of fish; but it is nothing of the sort. So too Dart is often said to mean that the stream is as swift as a dart; but after what I have said you will know better.

188. *Uisge.*—This means simply "water," and is preserved almost exactly in "whisky," which was called at first the "water of life," like the French name *eau-de-vie* for brandy. And this is the most curious of all the river names for its changes. The nearest to the old form are perhaps the Wisk in Yorkshire and the Usk in Monmouthshire; then comes Esk, of which there are nine, then Exe, Ax, Ux, and Ox—which has nothing to do with oxen, as the heralds supposed who gave Oxford its coat-of-arms—and Ose, at Oseney, the "island in the water" near Oxford; and then Use, Ouse, Ousel, Ouseburn, Ash, and Wish or Wis—in Wisbeach—and the Wash. The Isis is the same word, and the Tam-esis or THAMES is only the "broad water," because in old days it extended from where London stands to the Sydenham hills. On the whole there are not less than 50 streams named from Uisge, besides a large number of places and things. Phœnix Park, Dublin, strange as it seems, is a mere English corruption of Fion-uisge, from a clear spring there.

189. The fourth word is *Don*, which besides its own form appears as Dun, Dean, Dane, Davon, Devon, Tyne, Teign, Teyn, and so on.

These names are not confined to England. And we need only remember the Dordogne, the Adour,

* So Milton:

Or Trent, who, like some earth-born giant, spreads
His thirty arms along the indented meads.

the Douro; the Oxus, the Oise, the Iser, Osnaburg (which is really Osnabruck); the Don and the Danube, to see how widely spread they are.

190. A river is a drain for taking the water of a country to the ocean, and a **lake** is a natural tank for storing it up. Suppose a hollow place between two mountains, or two parts of a mountain. Streams flow down the slopes into it, and springs burst up in its bed, and the water collects in the hollow and rises till it finds a place where it can run away; and that is sometimes the source of a great river. Such is Derwent Water, or Loch Tay, or the lake of Zurich, or the Italian lakes, or the lake Sir-i-kol (now called Victoria) 15,600 feet high, and the source of the Oxus,

> In his high mountain cradle in Pamere.

Sometimes a river will flow in at one end and out at the other, as the Rhone runs through the lake of Geneva, and the Rhine through the lake of Constance, or the Jordan through the lake of Galilee. Sometimes a number of lakes will be connected together, as those of North America. (§ 79.)

191. Lakes are mostly in mountainous countries, such as Scotland, Cumberland, Switzerland, or Bavaria, where there are often convenient hollows for them to form in. Not so however the North American lakes which abound in Western Canada and Rupert's Land, and have flat shores, and seem to come from the extraordinary wetness of the country; nor the Sea of Aral; nor the great lakes of North Russia, Finland, and South Sweden, which are probably the remains of the water that once covered the whole of that low region, as Whittleseymere, in the Fen country in Huntingdon, is or was.

192. It is a great advantage to a river to run through a lake, because the lake regulates the flow of the water which goes away from it, and keeps it steady. If much rain falls in the mountains above, or the weather becomes hot and the snow melts quickly, it will come down into the upper part of the river in such sudden floods that the channel is not big enough to carry it off, and then it will overflow and wash away houses and fields and cattle, or, like the Indian rivers (§180), it will change its bed. But if there is a lake this is prevented, because the flood of water which was enough to fill the river to overflowing is only sufficient to make the lake rise a few inches or a few feet, and then the water gets time to flow away more quietly down the lower part of the river.

193. Lakes through which water flows are fresh. But sometimes the hollow in which the water collects is lower than the ocean, or so parted from it that there can be no outlet; in this case, the only escape for the water is by evaporation. The streams and the springs pour in to the lake, the sun heats the water and turns it into vapour, and the level at which the water stands is the balance of the two. This is the case in the Dead Sea. The water is continually being distilled by the sun, that is to say the pure water is driven off in vapour, and the salts and other ingredients remain behind in the lake. It is easy to see that the quantity of salts in the water must be continually increasing, while the quantity of water remains the same; so that the saltness must go on becoming more and more intense, till, as in the Dead Sea, the water is too bitter and hot to be borne in the mouth, or, as in lake Assal, in Eastern Africa, it is almost solid salt.

194. The Caspian and Aral are the largest of a great number of lakes, which receive the drainage of the central district of Asia—the so-called "continental district" already mentioned. Similar inland lakes are those of Titicaca in Bolivia, in the bosom of the Andes; lake Chad in the Sahara; and the Great Salt Lake in Utah, North America.

195. Lakes in Scotland are called **loch,** and in Ireland **lough**—both pronounced alike. A **tarn** is a small lake, usually high up in the mountains.

196. **Inland seas** are portions of the ocean, separated from it by a very narrow entrance. Such are the Red Sea, the Persian Gulf, and Hudson's Bay; but the most important are the Baltic and the Mediterranean (which means "in the midst of land"), including the Black Sea. These two receive between them more than half the waters of Europe. They have little or no tide, as their narrow entrances keep it out. They are, however, in some respects very different. The Baltic is shallow, the Mediterranean deep; the Baltic is diluted by its many rivers, and its water is not so salt as the ocean; while the Mediterranean, not receiving nearly so many rivers in proportion, and having a hot climate to evaporate the water, is salter than the ocean. The Mediterranean is agreeable, the Baltic inclement, both are treacherous. In each there is a constant current both out and in, but in the Mediterranean the outward current is below, and the inward one above; while in the Baltic it is exactly the reverse—the outgoing current is above, and the incoming one below. These two seas add enormously to the coast-line of Europe, and help to give it that great length which is one of the causes of its superiority to other parts of the world.

197. **Watershed** and **waterparting** are two words belonging to the supply of water to rivers. A **waterparting** is the spot or line at which the surface-water of a mountain, hill, or swelling ground parts, and begins to flow down the slope on each side. The **ridge of a roof is a waterparting**. It is the line between the rain which runs down the slates on

Fig. 22.

one side and the slates on the other. If the roof were nearly flat, like the top of a railway-carriage, the water

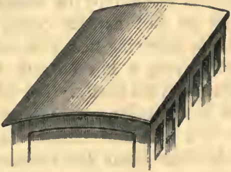

Fig. 23.

would still fall off on each side, and there would still be a line along the middle at which the parting took place. Some mountains have a ridge almost as sharp as that of the roof, others are more irregular. Some undulating ground is as flat as the top of the railway-carriage; and it is difficult to say by the eye where the line of waterparting is; and some ground is flat here, and round a little farther on, and broken here, and steep there; and then it is more difficult still. But water will always find its level, and there is always a line at which the water will know of itself where to go down the one side and where to go down the other; and that line, straight or crooked, is the waterparting. You may trace it on a good map, even to a small scale and in very flat countries, by noticing where the rivers start from. Here is a bit from the centre of Russia where the undulations of the ground are very slight:

Fig. 24.

The dotted line drawn midway between the various sources of the streams which flow different ways cannot be far from the waterparting of this flat district.

198. It is interesting, in going through a mountainous country, to see the parting of the streams. There is a good example on the Highland Railway a couple of miles north of Dalnaspidal, where the

streams of the Garry and the Truim—one of the tributaries of the Spey—may be seen to part and fall off, one down the one slope of the hill, the other down the other, as the train passes the waterparting. Sometimes the line will be very crooked, and the heads of the streams on each side will run back far past each other, and "overlap," as it is called. In the highlands of Central Palestine the streams flow down to the Mediterranean on one side, and the Jordan valley on the other; and there the heads of an eastern torrent will sometimes be 4 miles farther west than that of the western torrent next to it. In the central part of North America, at the waterparting of the Mississippi on the south and the Saskatchewan on the north, the sources of the rivers are sometimes so close, and the land between them so level, that boats can be carried over from one to the other; and in the rainy season, when the whole district is inundated, boats can even be rowed across.

199. The waterparting being the ridge or highest line between two streams, the **watershed** is the whole of the ground between the waterparting and the

Fig. 25.

stream. In fact, it is the slope of the roof. The ridge (fig. 25) is the **waterparting**; the slates on each side are the **watershed**; and the gutter (or furrow, or valley, for the builders call it by all three names) is the **river.** "Ridge and furrow" is the common builders' term for such a roof. The terms are actually borrowed from the land. Of course so simple a case as this will seldom or never occur in nature; the broad slope of the watershed will in the course of ages have become indented with smaller streams, each of which will have its own waterparting and watershed; but on the whole they will all slope down towards the main stream—the gutter—at the bottom; and carrying the principle in your head, you will have no difficulty in tracing the whole structure.

200. The **basin** is the whole area or space of ground which supplies the water to a river, lake, or ocean. In the first case it comprises not only the valley of the main river itself, but those of all the rivers and streams which run into it, with all their tributaries, up to the waterparting of each. The basin of the Thames includes the valleys of the Kennet, Wey, Mole, Darent, Medway, Cherwell, Thame, Colne, Lea, and other smaller streams, besides its own, and these cover in all 6,160 square miles. The basin of the Volga, the largest river of Europe, covers 520,000 square miles; that of the Rhone 38,000. The flatter the country the larger the basin.

201. The basin of a lake or ocean includes the basins of all the rivers which supply it, with all their tributaries. Take the Dead Sea as an example of a lake. Its basin includes on the north all the land drained by the Jordan, with all its streams and torrents east and west; the streams and torrents which fall direct into the lake itself, from Judæa

on the one side and Moab on the other; and on the south the great Wady el-Jeib, which drains the whole northern portion of the Arabah, including the western flanks of Mount Seir. Thus the basin of this not very extensive lake stretches from about 40 miles above Akabah on the south to beyond Rasheiyah and Mount Hermon on the north (240 miles), and from Nablus on the west to Sulkhad on the east (90 miles).

202. The basin of the Mediterranean includes the basins of all the rivers which drain into it in Europe, Asia, and Africa; while the basin of the Atlantic comprises the larger part of the continents of North and South America, the whole of Europe except that which drains into the Caspian, and a great portion of Africa. The basin of the Atlantic is calculated to cover on the whole the enormous area of 19 million square miles. (§ 95.)

203. **Coast**—that is, a rib or side—the edge of the land near the sea. We say a sandy coast, a rocky coast, an iron-bound coast. Coasting vessels are vessels which keep near the land, and a coasting trade is the traffic carried on in such vessels between two ports of the same country, as the coal trade between Newcastle and London. The two sides of India bear this name; on the Bombay side the Malabar coast, and on the Madras side the Coromandel coast. Costa Rica is the "rich coast." The word was formerly used for an inland boundary between two countries or districts. In this sense it is often employed in the topographical portions of the Bible (Josh. xiii. 16, 25; xv. 1, &c.).

204. **Gulf** and **bay.**—Each a recess in the coast; gulf usually perhaps the narrower and deeper, and bay the broader and more open, of the two, as the Persian Gulf and the Bay of Biscay. But the Gulf of Lions

(which has nothing to do with Lyons, though often so spelt) and the Gulf of Genoa are wide and open, while the Bay of Fundy and Chesapeake Bay are long and comparatively narrow inlets; and Hudson's Bay is an inland sea. The Gulf of Mexico is a vast lake with two narrow openings, through which the Gulf Stream flows, like the Rhine through the lake of Constance. The Bay of Salamis is practically a lake. In fact the words are used without any exactness.

Firths, friths, or **fiords,** are inlets or arms running up from the sea into the land. In the south of Scotland and north of Ireland these are sometimes called **lochs** or **loughs,** as at Loch Long, Loch Fyne; Lough Foyle, Belfast Lough, &c.

A **bight** (from a sailor's word, meaning the belly of a hanging rope) is a broad open bay; as the Bights of Biafra and Benin, and the Australian Bight—which are all of this form, and each several hundred miles long.

205. **Strait**—that is, the old English for "narrow"—a sea passage between two continents or islands. The best known are the Strait of Gibraltar, between Europe and Africa; Behring's Strait, between Eastern Asia and Russian America—the outlet of the Polar Sea into the Pacific; Davis's Strait, the entry from the Atlantic to Baffin's Bay, and the north-west passage; Torres Strait, between North Australia and New Guinea; the Strait of Magellan, between the islands of Tierra del Fuego and the mainland of South America, the most intricate and difficult of all; or, to come nearer home, the Menai Strait, between Carnarvonshire and Anglesey. The term Strait of Dover has now almost given way to that of The Channel—*la Manche*, or "the sleeve," as the French

call it. These examples shew that the word is used both for wide and narrow passages. The Dardanelles and Bosporus, the inlets to the Sea of Marmora, each excellent instances of a strait in its strictest sense, are seldom called by that name.

206. The word ***sound** is used for the narrow passage between Zealand and Sweden, and some other straits in that neighbourhood and the coast of Norway; and is frequent amongst the islands on the west coast of Scotland, which the Norse sailors greatly frequented in early times, and always for a long narrow passage. It has even travelled as far as Nantucket and Long island in North America. It is also applied to Plymouth harbour, which is rather to be called a bay.

207. Another Norse word is **belt**, applied to passages, broader than a sound, between the mainland and islands of Denmark. Possibly the origin of the name Baltic. **Gut** is also sometimes used. "*The* Gut" is at Gibraltar, and Canso Gut separates Nova Scotia from Breton. It is probably the same word with the last syllable of Katte*gat*, the broad strait between Denmark and Sweden—a gate or passage. A name of similar meaning is **the †minch,** which is used for the passage between the Hebrides and Scotland. **Kyles** is a Celtic word, frequent on the west and north of Scotland for a long narrow passage or inlet.

208. A **road** or **roadstead** is an anchorage, a part of the sea sufficiently shallow for ships to ride at anchor. Yarmouth Roads are a good example.

* Saxon, from the same root as "swim,"—a place which may be swum, or in which ships can swim.

† Minch; Gaelic, *mionach*, entrails. *La Manche* is perhaps the same word.

The Downs, off the coast of Kent, one of the most important roads in our seas—though not so called—take their name from the Dunes or sandhills of the Calais coast opposite, or perhaps of the Goodwin sands.

209. **Lagoons** are shallow pieces of water cut off from the sea or a river by the formation of a bank between the two, though still connected by one or more inlets. Such are the lagoons on the islands of which Venice is built. Such, though not so called, are the Frische Haff and Kurische Haff, in the Gulf of Dantzic in the Baltic. The name is also given to the basins of still water inside the atolls or round coral islands of the Pacific (§129). A view of them is given in the *Primer of Physical Geography*, p. 101.

The shallow basin at the south end of the Dead Sea is known as the lagoon.

210. **Icebergs** are masses of fresh-water ice, broken off from the points of glaciers, and set floating in the sea. The glaciers of the Arctic regions are formed in the valleys and creeks of Greenland, and are of immense width, and often many hundred feet in thickness. These push slowly down until they reach the sea, and project into it, sometimes as much as three miles. By the gradual working of the waves and the tide up and down, large pieces are broken off, and being lighter than water, float away. The icebergs in the Antarctic Ocean are built up in thin horizontal strata, of about a foot thick at the top of the berg, compressed to 2 or 3 inches at the water-line. Whether they are formed by glaciers, as in the Arctic Seas, is not yet ascertained. There is always eight times as much, in weight, of the iceberg below the water as above it, and when we are told

of one that floated 200 feet high and 3 miles long,

Fig. 26.

we may judge how enormous the whole mass was, for there may have been as much as 1,600 feet of ice under water. Another is said to have been seen 7 miles long and 4 wide—large enough to have blotted out London. They are not often so large, but an average size is a mile long, half a mile wide, and 200 feet out of the water; and they come in such numbers that it was said of one ship that "she could no more go among them than she could sail through the city of London if it were half sunk in the sea, with all the houses tumbling about and butting each other." By the *Challenger* (in S. lat. 63°–65°) they were seen in seventies and eighties at once. When an iceberg has been so much melted below the water as to destroy its balance, it will turn over and settle in a new position.

211. Icebergs have great quantities of large rocks frozen into them, which, as the ice gradually melts, drop down to the bottom of the sea. They have

been seen to carry blocks estimated at 100 tons weight. In this way many of the large round rocks, called boulders, which are found in England and Scotland, of different stone from any in that neighbourhood, have been dropped when the country was under water and the climate arctic.

212. In the Northern Hemisphere, the icebergs which come south, keep near the coasts of Greenland and Newfoundland, and though they come as far down as N. lat. 40°, yet they are seldom or never seen so far south in the open sea. The most southerly place in Europe at which a glacier comes down to the sea is on the coast of Norway, in N. lat. 67°. But in the Southern Hemisphere, so much greater is the coldness, that on the southern coast of Chili glaciers come down to the sea in lat. 46° 40′, or 20° 20′ nearer the Equator than with us, and the icebergs from the mass of land or of ice round the South Pole, advance across the ocean as far as 45° and even 40° S. lat., and make navigation impossible south of that line. At Kerguelen and Heard islands, south-east of Africa, in the corresponding latitude to Cornwall and Paris, not only do the glaciers come down to the water, but the islands have no vegetation higher than the Kerguelen cabbage, no inhabitants, and no animals but birds and seals.

213. Quite distinct from icebergs is the coast-ice, or floe-ice. This is frozen salt water, seldom more than 20 feet thick, and at that thickness would float at between 2 and 3 feet out of the water. It is of a dull colour, while the ice of the bergs is a beautiful blue. True, in the Arctic Expedition of 1875 the "ancient ice" of the Polar Sea was much thicker than that just named; but this seems to have arisen from the heaping up of fragments, when the ice is

broken up by the waves and masses are forced one on to the top of another.

And now I have done; not because I have said all there is to say, but because I have come to the end of my pages. I have tried to tell you three things:

1. How maps are made, and how they are to be understood.
2. How the land and water are placed on the world, and how the different countries are like and unlike each other.
3. How the separate parts or features of the land and water are made up.

But before we part you must let me give you a few words of advice. Don't be content with knowing your map, or your globe, or your geography book. The object of them all is to teach you about the earth, and they are no use if they don't do that. Get into the habit of looking at the country itself, of questioning its different parts, the mountains, valleys, rivers, roads, and finding out their connection with one another, and what they all mean in relation to ourselves. And this you will do by beginning at home. The most important spot for us all, in this and many other respects, is our own home. Not only Europe, not only Great Britain, not only England, but our part of England. Now I ask you. When you go out into the garden or street do you know where the North and South are? Roughly speaking, the South is where the sun stands at noon. Look up at that, and then the North is behind you, the West on your right, and the East on your left. And now go a step farther. What is there to the

South or West? As you stand outside the house and look South what are you looking towards? What is the first place you would come to if you walked or rode that way? the first large town? the first village? What rivers, or streams, or railways, would you come to? What sort of country is it? wooded or bare? grass or corn? hilly or flat? rounded or roughly broken? I doubt if you could answer these questions. But I would have you try, because these things are the foundation of geography, and the habit of questioning and finding out is the foundation of all knowledge. The very wind as it blows in your face prompts you to question it. What frosty regions has the North-east wind travelled over, to give it its icy keenness? Whence comes the South-west wind with its moist softness?

It is that sort of inquiry, begun at your own centre, and gradually widening to other countries and scenes, till you know all about them, which is the useful part of that great science of man and nature, of which geography is an important portion. Moreover, geography invites you to this, for it touches on almost everything high and low. Every rill that you see running down a lane into the road after the rain, will tell you something of the nature of the Ganges, if you look at it properly; and on the other hand, there is no subject of inquiry, natural sciences, commerce, history, religion, which is not more or less connected with the form and arrangement of earth and ocean, with mountains, rivers, coasts, or climate, and which they have not at some time or other materially influenced. We have noticed a few instances in the foregoing pages. Keep your eyes open, and you will see others every day of your life.

APPENDIX.

I. Measures of Length.

1. The *knot* (geographical or nautical mile, one minute, or one 21,600th part of the earth's circumference at the Equator) contains 2,028 yards, or 6,084 feet.

2. The English or statute *mile* contains 1,760 yards, or 5,280 feet.

3. The French *kilomètre* contains 1093·833 yards, or 3281 ft. 10 in.

4. Depths at sea are measured by *fathoms*, each containing 6 ft.

5. Comparative table of *knots* and *statute miles* :—

Knots.	Statute Miles.	Statute Miles.	Knots.
1	1·152	1	·868
2	2·304	2	1·736
3	3·457	3	2·603
4	4·609	4	3·471
5	5·761	5	4·339
6	6·914	6	5·207
7	8·066	7	6·075
8	9·218	8	6·943
9	10·370	9	7·811
10	11·523	10	8·678
20	23·045	20	17·357
30	34·568	30	26·035
40	46·091	40	34·714
50	57·613	50	43·392
60	69·136	60	52·071
70	80·659	70	60·749
80	92·181	80	69·428
90	103·704	90	78·106
100	115·227	100	86·785

II.

Table of the Number of Knots contained in a Degree of Longitude under each Parallel of Latitude.

Parallel of Latitude.	Length of Degree in Knots.	Parallel of Latitude.	Length of Degree.	Parallel of Latitude.	Length of Degree.
Equator	60·000	30°	52·004	60°	30·074
1°	59·991	31	51·475	61	29·161
2	59·964	32	50·930	62	28·240
3	59·918	33	50·370	63	27·310
4	59·854	34	49·793	64	26·372
5	59·773	35	49·202	65	25·426
6	59·673	36	48·596	66	24·471
7	59·556	37	47·975	67	23·509
8	59·419	38	47·339	68	22·540
9	59·266	39	46·688	69	21·564
10	59·094	40	46·021	70	20·581
11	58·905	41	45·346	71	19·592
12	58·697	42	44·654	72	18·596
13	58·472	43	43·948	73	17·595
14	58·229	44	43·229	74	16·588
15	57·968	45	42·495	75	15·577
16	57·690	46	41·750	76	14·560
17	57·394	47	40·992	77	13·539
18	57·081	48	40·220	78	12·514
19	56·751	49	39·437	79	11·485
20	56·403	50	38·642	80	10·452
21	56·038	51	37·834	81	9·416
22	55·657	52	37·015	82	8·377
23	55·258	53	36·185	83	7·366
24	54·842	54	35·343	84	6·292
25	54·410	55	34·400	85	5·246
26	53·962	56	33·627	86	4·199
27	53·496	57	32·754	87	3·150
28	53·015	58	31·870	88	2·101
29	52·518	59	30·977	89	1·050
30	52·004	60	30·074	Pole	0·000

III.

TABLE OF SCALES EMPLOYED IN ORDNANCE MAPS (See § 36).

Natural Scale.	Inches to One Statute Mile.	Class of Map.
$\frac{1}{500}$	126·720	Plans of towns.
$\frac{1}{528}$	120·	Ditto.
$\frac{1}{1000}$	63·36	Ditto.
$\frac{1}{1056}$	60·	Ditto.
$\frac{1}{1760}$	36	Special maps.
$\frac{1}{2376}$	26·6	Ditto.
$\frac{1}{2500}$	25·344	Parish plans. Cadastral survey.
$\frac{1}{2640}$	24·	Special maps.
$\frac{1}{5280}$	12·	Ditto.
$\frac{1}{10560}$	6·	County maps. Reconnaissances.
$\frac{1}{12672}$	5·	Indexes.
$\frac{1}{15840}$	4·	Special maps.
$\frac{1}{21120}$	3·	Indexes. Reconnaissances of roads.
$\frac{1}{31680}$	2·	Special maps.
$\frac{1}{63360}$	1·	General map of the United Kingdom.
$\frac{1}{253440}$	·25	Special maps (4 miles to an inch).
$\frac{1}{316800}$	·2	Ditto (5 miles to an inch).
$\frac{1}{633600}$	·1	Index map (10 miles to an inch).
$\frac{1}{1900800}$	·03	Special maps (30 miles to an inch).

In the Ordnance Maps:—

Turnpike or Main Roads, if fenced, are represented by two parallel lines, a thin and a thick, the thick one being the lower, or right-hand one, according to position. *Cross Roads* are narrower, and have both sides alike, two thin lines. *Footpaths* are shown by a single dotted line, and the sides of all roads, where they are not fenced, by dotted lines.

Rivers by two lines not strictly parallel, the upper one, or the left-hand one being thick; and the two open lines joining at last in one black line.

Ferries by a single dotted line. *Fords* by two dotted lines.

Railroads by thick parallel lines, connected by thin cross lines.

Canals by two lines, a thick and a thin, exactly parallel, the thick line being the upper one, or the left-hand one, according to position. Also by the locks and bridges.

Bridges.—A moderate-sized bridge is represented by two parallel lines with their ends bent outwards; smaller bridges by two small curves drawn back to back; the letters S, W, or I are added to show whether the bridges are of stone, wood, or iron.

Churches are marked with a cross.

Telegraph lines by short, thin, vertical strokes to represent the posts.

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